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TRANSACTIONS

OF THE

MASSACHUSETTS HORTICULTURAL SOCIETY

FOR THE YEAR 1917

PART I

PUBLISHED BY THE SOCIETY
BOSTON
NINETEEN HUNDRED AND SEVENTEEN

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Massachusetts Horticultural Society

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MASSACHUSETTS HORTICULTURAL SOCIETY.

1917.

The Transactions of the Society are issued annually in two parts under the direction of the Committee on Lectures and Publications.

Communications relating to the objects of the Society, its publications, exhibitions, and membership, may be addressed to William P. Rich, Secretary, Horticultural Hall, No. 300 Massachusetts Avenue, Boston, Massachusetts.

FRED A. WILSON, *Chairman*
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NATHANIEL T. KIDDER
} *Committee on Lectures and Publications.*

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THE INAUGURAL MEETING, JANUARY 13, 1917.

TRANSACTIONS

OF THE

Massachusetts Horticultural Society.

1917, PART I.

INAUGURAL MEETING.

The Inaugural Meeting of the Massachusetts Horticultural Society for the year 1917 was held at Horticultural Hall, Boston, on Saturday, January 13, at twelve o'clock, with President Saltonstall in the Chair.

The call for the meeting was read by the Secretary and the record of the previous meeting was read and approved. The President then proceeded to deliver his Inaugural Address.

Inaugural Address of President Saltonstall.

Ladies and Gentlemen,

Members of the Massachusetts Horticultural Society:

I have derived very great pleasure from my work for the Society during the past year. The year has been one of progress although nothing of special importance has occurred. There are, however, some matters worthy of note:—

There have been ten exhibitions during the year, and something over $8,000 awarded in prizes. The large May Show was well arranged and created much favorable comment. Almost $1600.00 was contributed by members for special prizes at this show which indicates an active desire on the part of our members to coöperate.

The Fall Show is also worthy of special mention; favorable comment should be made of the fruits and vegetables which certainly rivalled in interest the exhibition of plants and flowers.

The semi-monthly exhibitions during the year have not been a

success, but it is believed advisable to have monthly exhibitions during the flowering seasons for their educational features.

Our receipts from exhibitions during the year increased from $2,097.22 to $3,909.14. This opens up good hopes for the coming year. The expenditures of the Society for the four years prior to 1916 showed excess expenditures of about $7,700 which is a very serious matter. This year our receipts exceed expenditures by about $1,060 and this small surplus should be applied against losses of previous years or held as a reserve against insurance, large premiums falling due this year.

In this connection it is pleasing to note that during the year the Society received a bequest under the will of Miss Helen Collamore, daughter of John Collamore, a former well-known resident of Boston, of five thousand dollars ($5,000) which by vote of the Trustees has been added to the permanent fund of the Society.

Our Library is one of the finest in the country, containing over twenty thousand (20,000) volumes, all well catalogued. Its usefulness will be greatly extended by printing the catalogue, the estimated expense of which is approximately four thousand dollars ($4,000) of which amount fifteen hundred dollars ($1,500) has already been subscribed by members. This subscription by members is another instance of their warm support.

The lectures of the year maintained a high standard for interest and usefulness as is shown by the following program:

Ernest H. Wilson	Flowers and Gardens of Japan.
Dr. George T. Moore	The Missouri Botanical Garden.
Prof. S. C. Damon	Alfalfa Culture in New England.
W. T. Macoun	The Development of Fruits for Special Conditions.
George C. Husmann	Some History of the Grape in the United States.
Leonard Barron	Garden Writings in America.
T. D. Hatfield	Methods used in the Propagation of Plants.
Frederick V. Coville	Taming the Wild Blueberry.
Frank N. Meyer	Economic Botanical Explorations in China.
J. J. Taubenhaus	Sweet Pea Diseases and their Control.

The lectures are certainly to be continued for another year.

The award of the George Robert White Medal of Honor: A continuing vote of thanks from the members of the Society is due to Mr. White for his gift to the Society of seven thousand five hundred dollars ($7,500) which enables the annual award of the substantial gold medal to the one who has done most for advancement of the interest in horticulture in recent years. This year the medal was awarded to William Robinson of Sussex, England, who has stimulated so much interest by his writings on horticultural subjects.

Now let us turn our thoughts to the coming year. It should be the aim of the Society, first, to stimulate a broader interest in horticulture in all its branches, flowers, fruits, and vegetables. One of the means for best accomplishing this result is to increase our membership. We have now 760 life members and 165 annual members; a total of 925. In 1915 we had 934 members. In 1871 we had over 1,000 members. We have really gone back a bit during the year. Let us increase the membership at least 100 during this year.

Exhibitions: A year ago the Trustees conceived the plan of having one or two special shows during the year. It was the show in May, last year, the object of which was to attract exhibits from a wider field, to stimulate the growing of new varieties, to eliminate as far as possible repetition from year to year of the same class of exhibits, and to effect this result, it is proposed to have the special shows come at different times of the year.

The special exhibitions this year are to be the March Show, the Outdoor June Show, and the October Fruit Show. March Show: Something over $4,000 in prizes have been provided for this Show, this being a favorable season for indoor products. June Outdoor Show: The Society has held out-of-door shows three times during its existence,— the first in 1852, Public Gardens; the second in 1855, Boston Common; the third in 1873, on Boston Common under the supervision of Mr. Hollis Hunnewell and Prof. Charles S. Sargent. Mr. Hunnewell guaranteed the Society against loss from this show, but instead of resulting in a loss, the Society made a handsome return. Prof. Sargent and Mr. Walter Hunnewell may be called the sponsors for the coming show in June. The grounds

of the Arioch Wentworth Institute on Huntington Avenue, containing about 3 acres, will be graded and enclosed, and an artificial pond will be constructed. Five separate tents will be provided for the different exhibits and there will be another tent for a general exhibit. Professor Sargent will exhibit azaleas, Mr. Thomas Roland will exhibit roses, Mr. Farquhar will exhibit a rock garden, Messrs. Dane, Cooley, and others will exhibit orchids. 250 rhododendrons are already on way from England from Mr. Waterer, and rhododendrons will also be exhibited by Mr. Hunnewell. There will be no money prizes except such Special Prizes as may be offered by members or friends of the Society. The general plan follows that adopted in the London Shows.

No expense of any kind will fall upon the Society. An admission fee will be charged and it is hoped in this way to cover expenses; the loss, if any, is to be borne by various subscribers, a dozen or more having already signed a promise to this effect. We expect that the show will excel anything of the kind ever given in this country, and every member should interest himself in its success. Mr. Thomas Allen is in general charge, and any member may secure space by applying to him. Any member who may expect to have anything to show should give early notice as the space is fast being allotted.

The Fall Fruit Show in conjunction with the biennial meetings of the Pomological Society and the New England Fruit Show will be held some time in October. The Society has appropriated $2,000 for prizes and expenses incident to this show of which $1,000 is to be raised by subscriptions from members and friends of the Society.

This general statement of our purposes for the year we hope indicates to our members that the Trustees are working hard to advance the work in which our Society is engaged. Please remember that it is always easy to criticise and find fault. Take hold and do constructive work, and do not stand on the side lines ready to criticise what others are earnestly trying to accomplish.

For a busy lawyer who is very much of an amateur in the science of horticulture, it is not easy at times to give the time and thought required to assist in carrying along these various undertakings. Any effort, to accomplish good results, requires time, thought and energy from those in charge. I pledge myself to give freely of

these during this year, certainly the last year of my presidency, but I must have your coöperation and support to accomplish successful results.

At the conclusion of his address the President called for the reports of officers and chairmen of committees which were presented in the following order:

Report of the Treasurer, Walter Hunnewell.

Report of the Board of Trustees, by the Secretary.

Report of the Committee on Prizes and Exhibitions, James Wheeler, Chairman.

Report of the Committee on Plants and Flowers, William Anderson, Chairman.

Report of the Committee on Fruits, Edward B. Wilder, Chairman.

Report of the Committee on Vegetables, John L. Smith, Chairman.

Report of the Committee on Gardens, Richard M. Saltonstall, Chairman.

Report of the Committee on Children's Gardens, Henry S. Adams, Chairman.

Report of the Delegate to the State Board of Agriculture, Edward B. Wilder.

Report of the Committee on Lectures and Publications, Wilfrid Wheeler, Chairman.

Report of the Secretary and Librarian.

The various reports were separately accepted with thanks and referred to the Committee on Publications for record in the Transactions of the Society.

The meeting was then dissolved.

WILLIAM P. RICH,
Secretary.

HORTICULTURAL PAPERS.

SEED SOWING SUGGESTIONS.

By William N. Craig, Brookline, Mass.

Delivered before the Society, January 20, 1917.

Of the various methods of propagation in common usage, which include layering, grafting, budding, leaf cuttings, shoot cuttings, roots, and seeds, the last named is many times more important horticulturally as well as agriculturally than all others combined. There may be less skill necessary in the production of plants from seeds than other methods named, which are in many cases necessary for the keeping of true stocks, and in some instances seed propagation would be undesirable, but broadly speaking both horticulture and agriculture depend overwhelmingly for their existence on seeds. This be it noted is Nature's plan in forest and field the world over, in tropical, temperate, and arctic climes. It is far the most natural method whereby the majority of plants reproduce themselves, not always absolutely true to type, as this depends on insect agencies and foreign pollen which affect their fertilization. If, however, all plants naturally reproduced themselves true from seeds the wonderful variations we have in plants, flowers, and other forms of plant life could not have been obtained by cross breeding, and artificial fertilization and improvements made would necessarily have been very much slower. A seed is botanically a ripened ovule; it contains what is called an embryo or miniature plant, with leaves, a bud, and a descending axis; it is in brief a little dormant plant. What are in a broad sense termed seeds are in many cases fruits; some of these contain more than one seed or growing points, as in the case of such plants as beets, mangel wurzel, seakale, and lettuce. Nuts in variety, acorns etc. are really fruits; so are some of the cereals, and seeds of raspberries, blackberries, strawberries, and other fruits. Many winged seeds flying from such trees as elms, maples, and lindens are fruits containing a single seed. The wind carries many of these long distances, and thus disseminates them more widely; birds and

animals assist in the wider distribution of nuts, acorns, and numerous seeds.

It would be easily possible to speak for an entire afternoon on the fascinating subjects of seed distribution throughout the world; sources of seed supplies, and quantities and values of seeds produced; but it is my purpose rather to discuss the somewhat more limited, but more practical side of seed sowing itself. This may seem to many to be a very simple task, but owing to the fact that many seeds require quite long periods for germination, that many are almost infinitesimal in size and need very careful sowing, and that there are peculiarities in not a few varieties which demand special treatment for them, the field of seed sowing is less narrow than many might imagine.

The great European war has seriously impaired the supply of many seeds on which America has in the past depended; particularly is this the case with flower seeds, but vegetables are likewise affected. Blockades prevent more than a fractional part of our average annual importations from arriving, embargoes by certain of the belligerent nations prevent the exportations of certain varieties, and as America is as yet unprepared to produce seeds of as pure quality and moderate cost as many of those received from Europe, there are likely to be acute shortages in certain varieties this season, while the seeds will probably be less pure in quality and there will be more errors in nomenclature. Purchasers of seeds should remember these things, place their seed orders early and be patient pending deliveries.

We now produce in America an immense quantity of both flower and vegetable seeds, and could no doubt profitably raise many more, but not all that we need. The countries of the world will continue to be more or less inter-dependent on each other for seeds as for many other necessary commodities. Certain favorable soil and climatic conditions are necessary for the successful production of all seeds, and even we with our big country and much diversified climate cannot secure all of these vital requirements.

The annual wastage in purchased seeds is tremendous; particularly is this the case with the large and increasing army of amateur cultivators, who derive much pleasure while making their seed selections during the winter months from the numerous attractive catalogues and who invariably start their gardening with consider-

able enthusiasm, which latter quality, alas, in too many cases becomes evanescent before the crops come to maturity. Much seed is annually lost by improper conditions of the soil at sowing time, by seeding far too thickly, and not infrequently sowing in drills in which chemical fertilizers have been scattered and not properly incorporated with the soil. Seedsmen are annually blamed for many "crop failures" which are traceable to seed sowing in drills too heavily fertilized, in which the chemicals have not been properly mixed with mother earth.

Points of merit to be considered about good farm and garden seeds are: that they are able to produce vigorous or normal plants, that they are true to strain or name, and carry no impurities or adulterations. In the case of grass seeds adulterations are still too abundant, but conditions, thanks to government inspections, are steadily improving. Whether seeds have virility depends in great measure on the condition of the plants producing them, also on their age and the way they have been grown and stored.

Certain seeds like melons, beets, carrots, rape, squash, turnip, and cabbage have good germinating qualities for five or six years, in fact, 10-year-old seeds of some of these will grow, and I have in mind a case which came under my own personal notice 35 years ago, when I had occasion to sow seeds of a one-time favorite melon named Munro's Little Heath in a hot-bed; the seeds had been kept for over 18 years yet they germinated well and the melons fruited satisfactorily. On the other hand sweet corn, millet, parsnip, wheat, onion, soy beans, peas, and oats have lost their power of germination in large measure in two or three years.

Much of the success or failure in seed sowing depends on the proper preparation of the beds for all outdoor crops; a really vigorous start is a long step towards a good crop. The correct preparation of the soil has for its main object a good seed bed, the increasing of root pasturage, and the amelioration of the soil chemically and physically. If seeds germinate freely it should be in close contact with a thoroughly pulverized and later firmly settled soil. Both hand and horse tools are available in plenty for pulverizing the soil. The drier it is at seeding time, the more necessary it is to firm well by rolling or some other method, in order to secure a good germination.

There is an immense variety of seeds with widely varying needs.

I will speak briefly on the requirements of the various classes into which these are divided. There is an old axiom which says that in order to have seeds germinate well they should be covered with twice their own diameter of soil. This is hardly correct. It is true that the majority of seeds might germinate well if treated thus, but in the case of outdoor crops much depends on the time of year seeds are sown. For instance — taking vegetables first — garden peas when sown very early should not be covered more than 2–2½ inches, successional sowings should go an inch deeper, and late sowings, made from May 20 to June 15, from 4½ to 5 inches deep. When the soil is very dry it materially hastens germination to run a watering can along the drills and dampen the seeds well; this is preferable to soaking the seeds over night. The latter plan, good in many ways, has some drawbacks. There is always danger of soaking rains rendering the soil unfit for seed sowing at the time the peas should go in. A point worth remembering about peas is, that they are the most nutritious of any vegetables; they extract a great deal of nourishment from the soil and for that reason they should, if possible, be given a piece of ground well manured for some crop like celery the year previously. If the fertilizing element is placed too near the seeds the plants do not root freely, hence the desirability of keeping it some distance away, incorporating it well with the soil, and thus make the roots more active. Peas are the most important pecuniarily of all garden vegetables, seed sales of them exceed that of the three next most important vegetables combined.

Root crops such as carrots, beets, parsnips, salsify, turnips, and scorzonera should be sown on land on which no fresh manure has been used, if clean roots are desired; ground well manured the previous year will suit them to a nicety. Carrots and turnips are easily sown too thickly; this entails a lot of additional work at thinning time. For the later sowings be sure to firm the soil well if the ground is very dry. It is not unusual in a dry season for seeds of root crops to lie dormant for a number of weeks. If seeds of the various root crops are covered an average of one inch it will be found about right.

Hot-beds or cold frames are invaluable for starting many vegetable and flower seeds in; even a very small garden should contain

one. It is best to excavate it to a depth of 12–18 inches, place warm manure mixed with leaves in this, watering it if at all dry, and then thoroughly tramping it; over this place 4 inches of soil consisting preferably of loam and very old, well-rotted and pulverized manure, use some leaf mold if soil is at all heavy, screen at least the upper half of the soil, draw shallow drills and in them sow seeds, very lightly cover, of early cabbage, cauliflower, lettuce, tomato, egg plant, celery, and pepper. It is well to remember that seeds sown in cold frames, or in flats or pans in a greenhouse, need much lighter covering than the same varieties of seeds sown outdoors.

Do not sow vegetables or flower seeds broadcast in the frames, nor outdoors; if in drills it is possible to cultivate between them, also weed and thin them; for seeds of slow germination broadcasting is permissible but it is a slovenly system for outdoor crops which make quick growth and will yield at best but half a crop. It is a system which can safely be commended to the lazy man who would be satisfied with a fraction of a crop.

If birds or rodents trouble peas, beans, squash, sweet corn, and other crops, roll the seeds in a mixture of coal tar and lime before sowing, one taste usually suffices for either feathered or furry foes. The coating of tar and lime will not affect the germinating qualities of the seeds treated. Mice are sometimes very troublesome where lettuce, tomato, endive, and other small vegetable seeds are started under glass; traps and cats are useful, but a little white arsenic mixed in toasted cornflakes which have been slightly moistened acts even more effectively.

Success with onions is more certain if the same ground is used for them each year, and if it is thoroughly firmed before drills are drawn at all. In choosing a seed bed for cabbage, cauliflower, Brussels sprouts, and savoys be sure to select one which is free from club root, or better not sow at all; this disease annually destroys many of the Brassicas and its presence shows an over acid condition of the soil, which a liberal dressing of lime in the fall will help to remedy. Always sow seeds of this class of vegetables thinly in the drills; if not you must thin while small or plants will be pure weaklings. Remember that leafy crops such as spinach, Swiss chard, lettuce, endive, and rhubarb should have a soil rich in nitrogen, the best form of which is good barnyard manure and that fruiting varieties

such as tomatoes, egg plants, and peppers like considerable potash in the soil. If you like sweet corn sow an early batch an inch deep about April 20, later sowings two inches deep, and as late as July 4 for an average season. No garden can be called complete without its patch of herbs; sow any of these from May 1 to 15; cover such fine seeds as thyme and sweet marjoram very sparingly; summer savory, dill, fennel, sweet basil, lavender, borage, and other sorts can be covered one inch.

I have only touched on some vegetables but must now turn to flowers; these on the whole need much more careful covering than vegetables. Of the better known and hardier annuals, quite a number are better started in a hot-bed or greenhouse; this includes such popular subjects as asters, stocks, salpiglossis, salvias, zinnias, marigolds, nemesias, verbenas, petunias, vincas, lobelias, phlox drummondi, snapdragons, and balsams. The majority of these may also be started outdoors but it is much more satisfactory to start under glass. Petunias and lobelias have very small seeds and should be sown in pans which should be well drained, some moss placed over the drainage, a little coarse soil over this, and the balance should consist of equal parts loam and leaf mold with a good dash of sand through it; this should be passed through a fine screen, then pressed firmly in the pans with a piece of board, watered with a watering pot with a fine rose, dusted with sand, and the fine seeds scattered over this. Take a pinch of seed between the forefinger and thumb and distribute it as evenly as possible over the surface and do not cover the seed at all. To prevent seed washing to the side of the pans cut a piece of tissue paper and lay over the surface of the pans and water over this; it helps to prevent drying of the soil and stops seed washing; it decays and allows seedlings to push through it readily. This plan is not necessary where experts are sowing and caring for seeds but it will prove useful to amateurs sowing such small seeds as petunias, lobelias, begonias, gloxinias, mimulus, etc.

Such well known annuals as bachelor's buttons, mignonette, candytuft, lupines, poppies, sweet alyssum, and godetias can be sown as soon as frost has left the ground and it has dried sufficiently to be workable. Sweet peas cannot be sown too early after frost has gone; the roots will go well down into the cool, moist earth

before the growths appear; cover two inches deep but never hill up, as too many catalogues and magazine writers recommend, or you will regret it.

Sow that splendid annual hunnemannia or Mexican poppy about May 10, which is also a safe date to sow salpiglossis, one of our most beautiful annuals, and others which are more or less tender. Such annuals as scabious, brachycomes, gypsophila, sweet sultan, clarkia, portulacas, calendulas, coreopsis, statices, chrysanthemums, larkspurs, dianthus, sunflowers, gaillardias, schizanthus, nemophila, love-in-a-mist, eschscholtzias, and cosmos may be safely sown any time after April 15 in this latitude if the ground has become dry; if not it is safer to wait a couple of weeks. Such subjects as gypsophila elegans, larkspurs, shirley poppies, clarkias, schizanthus, candytuft, and sweet alyssum should be sown two or three times to secure a succession of bloom, making the last sowing as near June 1 as possible.

Hardy herbaceous perennials are wonderfully popular now. I well remember the fight waged by Mr. William Robinson through the columns of the English "Garden" to secure them suitable recognition in the early '80's of the last century. A great proportion of these hardy plants are easily and inexpensively raised from seed. Taking first those usually treated as biennials, but some of which are perennial, we have pansies, bedding violas, double daisies, rockets, forget-me-nots, Canterbury bells, foxgloves, hollyhocks, and honesty; of these, pansies, violas, forget-me-nots and daisies should be sown in a cold frame, or in a shaded position outdoors from July 25 to August 1. Foxgloves and Canterbury bells need sowing in May, and hollyhocks in early July. For anyone unable to succeed with the perennial hollyhocks I would commend the annual type; these sown in April will flower well the same season, and rarely are affected by rust.

Amongst the varieties of hardy perennials which come with ease from seeds are: delphiniums, aquilegias, campanulas, centaureas, shasta daisies, poppies, thalictrums, lupines, galegas, hibiscus, pentstemons, doronicums, eryngiums, asters, and kniphofias; any of these will start readily in cold frames in light soil in April and May or August, or if strong plants are wanted in the fall, sowing can be done in flats or pans in a greenhouse in January or February.

Some perennials of slower germination are anemones, aconitums, dictamnus, trollius, some eupatoriums, some primulas and liliums, which latter are bulbous but are popular subjects in the hardy flower border. The varieties of slow germination are better sown in the fall when the seed is ripe and fresh; it will do no harm to allow the soil to freeze over winter, but the flats or seed beds should be mulched with dry leaves, tight sashes being placed over these.

Rock or alpine plants have become immensely popular the last two or three years and deservedly so; this is one of the most fascinating types of gardening, and a large proportion of the plants adaptable for rock gardens can be raised from seed, while many germinate very readily. Others are quite slow, occasionally requiring one or even two years to start. Some of those which appear quickly above ground are alyssums, aubrietias, arabis, campanulas, dianthus, arenarias, violas, many sedums, many primulas, potentillas, tunicas, geums, leontopodiums, androsaces, myosotis, cheiranthus, linarias, veronicas, and geraniums. Seed of rock plants can be sown in flats, or pans in a greenhouse, or in very shallow drills 6 inches apart in cold frames. I like to bake the soil for covering the seeds; this kills out all weed seeds and fungoid growths; it should be sifted over them through a fine screen. Seedlings if pricked out into other cold frames when of sufficient size and kept well watered can in the majority of cases be safely planted out in September, and if lightly mulched will winter perfectly, and bloom much better than the same stock planted out the following spring.

Coming to seeds of tender greenhouse plants, such varieties as gloxinias, tuberous begonias, gesnerias, tydaeas, and others with very fine seeds should be sown in pans of prepared compost as recommended for petunias and other garden annuals. The greatest care is necessary in sowing each of these; pans must be watered before and not immediately after seed is sown, sheets of glass should cover all pans, and paper or cloth be placed over this to exclude sunlight and prevent drying out; gradually remove the coverings as germination starts. Calceolarias have fine seeds and a fine dusting of sand is all the covering they need; over cinerarias should be placed a little fine earth; the same is true of primulas. Cycla-

mens like a very light covering of fine sandy soil. The proper time to sow gloxinias, begonias, and gesnerias is January; primulas sinensis, obconica, and kewensis should be started in January or February, but the beautiful and decorative P. malacoides not until July; calceolarias and cinerarias can also be started in July and cyclamens in August. Schizanthus, nemesias, calendulas, mignonette, statices and other annuals for flowering under glass should be sown in August and September, and snapdragons for early winter flowering not later than May 15. All greenhouse seeds sown in winter need a warm, moist house in which to germinate.

Seeds of such palms as cocos, phoenix, kentia, and latania if fresh usually germinate readily if sown in pans and plunged in a brisk bottom heat in a warm house. Anthuriums want similar treatment, but like to be sown in a mixture of chopped fern root and sphagnum moss. Seeds of crotons, dracaenas, marantas, and various tropical plants all need a brisk moist heat. Cannas have very hard seeds and start better if some of the shell is cut with a sharp knife, taking care not to cut the growing point; seeds should be soaked in tepid water for 24 hours before sowing; moonflowers need similar treatment. Sweet peas, especially light shelled varieties, if trimmed with a knife also start better and this plan is suggested for the more valuable varieties to be started under glass. Cobaea scandens, a popular climber, germinates better if the seeds are stood edgewise in the pots or pans.

Orchid seeds require radically different treatment from those of all other plants. Seed pods of cattleyas usually ripen about a year after fertilization; a pod will contain anywhere from 200,000 to 500,000 seeds which are remarkably fine and light. All orchid seeds germinate best if sown in spring; they are less certain if started in summer or winter. I have had the best success with cattleyas, laelio-cattleyas, and other bi-generic hybrids, also cypripediums, by sowing the seeds on coarse bath towel or burlap stretched inside a glass case, the same being damped before seeds are sown, or in filling 4 inch pots with chopped fern fibre and over the tops laying pieces of bath towel and tucking them closely down the inside edges of the pots with a pointed stick, having the surface raised and well rounded. Seed can be sown at the rate of 20,000 or more per square inch; sometimes none will germinate, the seed being barren,

at other times one or two may start, but sometimes the surfaces will be covered with tiny seedlings; these not infrequently start from the sides of the pots. Sometimes seedlings will appear within a month, at other times not for six or more months; great care is necessary in spraying, ventilating and shading the cases, and insect pests and fungoid growths must be fought. Under the most favorable conditions seedlings may flower in three to five years, but many of the best crosses require double that length of time. The orchid seedling raiser must be a pure specialist; he needs lots of patience and must never be of a nervous temperament.

Aquatic plants such as Nymphaeas and Nelumbiums germinate well if seeds are sown in small pots singly and submerged in tanks or trays of warm water in a warm house; if started in early spring the majority will attain sufficient size to flower the first season.

Ferns are raised from spores which when ripe should be cut off, placed in small bags, kept for a few days and then sown in square pans of a compost consisting of equal parts loam and peat with a good dash of sand mixed with it, and sterilized in advance; pans must be watered before spores are sown and pans must be kept in a close moist case to ensure good germination.

The propagation of trees and shrubs from seeds would use up an entire afternoon in itself if gone into at all thoroughly; I can only refer to a few of each. The propagation of both trees and shrubs is left almost entirely in the hands of nurserymen, with the exception of a limited number of private estates and such institutions as the Arnold Arboretum. There is no good reason why many more small growers should not do a little of this propagating as many varieties come very easily from seed; in many cases starting almost as quickly as our common annuals.

The various pines, spruces, firs, and thujas can be sown in early May in open frames in well pulverized soil which should be levelled and then well watered; sow the seed broadcast rather than in drills as the plants must remain at least one year in the seed beds; after seeding, sift a light covering of fine loam over the beds, cover this with a mulch of leaves slightly decayed. A safe plan is to enclose the ground or grounds with fine mesh wire netting to prevent birds or animals entering and scratching, and later cover the top with burlap. In about 30 days seedlings (under normal conditions)

of pines and spruces will be germinated sufficiently so that the mold can be removed. Seeds of evergreens are light. A pound of white pine will average 15,000 to 20,000 seeds and one of red pine 28,000 to 30,000, and if the seed is fresh the larger proportion should grow. In small batches evergreen tree seeds can be sown in pans or shallow flats in an ordinary greenhouse. All evergreens do not start so readily as those named however, and in the cases of most of the junipers and yews, germination is slow, seeds frequently not starting until the second year. As between sowing seeds of the slow germinating ones in fall or spring the former season is best if a greenhouse is at command, the seeds being then fresher.

Rhododendrons, kalmias, andromedas, callunas, ericas, and azaleas start best in pans of sandy peat, over which a thin layer of fine dry sphagnum moss is screened; the seed can be sown over this, and water then applied through a fine rose; seed will germinate much better sown on moss than direct on the soil; a temperature of 55° will suit those seeds in the early stages of growth.

Nuts of various kinds, also acorns, are better sown soon after harvesting and exposed to frost which loosens the shells and makes germination more easy. If not sown in late fall, it is better to carry them over winter in moist sand. Fruits of many plants including cotoneasters, hawthorns, hollies, loniceras, pyrus, and other fruiting varieties, should be stratified in dry sand if not sown in late fall outdoors or in the greenhouse; if outdoors they must be mulched. Freezing undoubtedly advances the time of germination of many seeds, but seed beds and pans will in many cases require to be kept a second season, as a large number will not start the first year. The longer seeds of this kind are kept in a dry state, the slower they will be in starting.

On the other hand many deciduous shrubs like buddleias, lilacs, deutzias, spiraeas, and viburnums come very readily from seeds. Shallow flats or pans containing sandy loam seem adaptable to about all tree and shrub seeds except the members of the ericaceae family which prefer a peaty soil. Elms, maples, and lindens all come easily from seeds which can be sown either in fall or spring. There are some slow and fussy subjects amongst trees and shrubs just as there are amongst other plants. It would take too long to mention each specifically; as a general rule trees and shrubs are

not much more difficult to raise from seeds than are annuals and perennials. Clematis paniculata is better sown as soon as ripe, the seeds will then appear in abundance the following summer; if not sown until spring a large proportion will not appear until the second season.

Lawn seeding is too often improperly done; it should be preceded, in the case of new lawns by very careful preparation of the soil, frequent raking being necessary to make a perfect seed bed. The seed being very light, a calm day should be selected for seeding. A common mistake made is in sowing too thickly. Heavily seeded lawns may look well at first and give a good immediate effect, but the individual plants being so terribly crowded lack vigor, and it is not by any means unusual during spells of hot, moist, and dark weather to find rot setting in, this will not occur when seed is sown more thinly. As a general rule 40–50 pounds of lawn seed should suffice for an acre, but as quality is very variable this may sometimes prove insufficient. The best all-around grass for our New England lawns is Kentucky blue grass, to which should be added some red top and Rhode Island bent, and where clover is liked add a little white clover. The best time to do seeding is from mid-August to mid-September; the next best period is from April 10 to May 15. To seed a lawn properly seed should be sown both lengthwise and crosswise; there are then unlikely to be any bare patches. A thorough raking and rolling must follow seedings and this rolling can advantageously be done several times through the season. In seeding bare patches on well established lawns, first scratch the spaces to be seeded and next mix some fine loam with grass seed and scatter over said bare spots. This is better than scattering the seed over the vacant patches and giving these a scratch with an iron rake. For permanent pastures August is far the best month to do seeding; spring seeding is usually more or less of a failure.

A point worth emphasizing is that seedlings of many garden plants possess much greater vigor and are more disease proof than the same varieties raised from cuttings. Hollyhocks and verbenas were some years ago decimated by disease and their very extinction even was threatened owing to their persistent propagation from cuttings over a long term of years. Since seedlings were raised

nearly all this debility has passed; the same is true of cinerarias. Of late years antirrhinums have advanced tremendously in popularity both as an indoor and outdoor plant. Under glass it has been clearly proven that seedlings are more vigorous, more floriferous, and vastly more disease resistant than plants raised from cuttings. Amongst vegetables there is simply no comparison in the vigor of tomatoes and cucumbers propagated from cuttings as compared with seedlings. Cuttings we know will always be necessary to secure fixed types of many plants, but seeds are and will be the principal means whereby plants of the majority of garden plants are to be propagated and perpetuated.

I must admit that I have omitted mention of a whole host of plants which can be raised from seeds, but this lecture has its limitations and I would not like to try the patience of my audience too much. To those about to purchase seeds I would say secure the best, as they prove to be the cheapest in the end. Do not trust too much to free seeds from Washington; a large percentage of these are old and inferior varieties. Free seed distribution would be a decided benefit if small sample packets of new, choice, and really desirable varieties were sent out to be tested, but as at present carried out, free seed distribution has little to recommend it, apart from benefits which may accrue to certain congressmen and their constituents, and the practice has for years been condemned by practically all horticultural and agricultural periodicals and bodies in America.

For past improvements in garden plants we owe debts of gratitude to many untiring specialists, and their continued efforts will still further benefit us. Finality is unattainable in the plant world and this adds a wondrous charm to horticulture. Novelties we are getting year by year are ever welcome and should always be given a fair trial. Do not condemn novelties after one season's test; frequently a second year may greatly improve them. We must continue to depend for our supplies on tried and tested varieties which experience has taught us will succeed best in our special soils and gardens. By growing good varieties, growing them as well as we can, and adding novelties as they appear, we will have not only good produce in abundance but our gardens will year by year furnish new points to attract and enthuse us.

THE FORMATION AND CHARACTERISTICS OF MASSACHUSETTS PEAT LANDS AND SOME OF THEIR USES.

By Dr. Alfred P. Dachnowski, Washington, D. C.

Delivered before the Society, January 27, 1917.
Illustrated by means of lantern slides and samples of peat material.

Reference to any good topographic map of Massachusetts will show a surprisingly large number of unimproved peat lands favorably located to various important market centers and to the chief lines of transportation radiating from Boston. In no state of the Union is the development of peat land resources for their food yielding value of greater importance than in Massachusetts, where agriculture in the last 5 years has seen a great change and in the further growth of which are interested the commercial and industrial prosperity of over 4,000,000 people.

The passage of legislation by the State Board of Health for the drainage of some of these peat lands and the establishment of a provision to extend the activities of the drainage engineers to aid in the preparation of peat lands for agricultural and other purposes constitutes a notable recognition of agriculture in a new direction. Not only does this imply the harmonious working together for ends of a common good, but more primarily the realization that the great peat land areas can be made a valuable resource to the state only through well planned measures controlled by State Departments working in cooperation.

Today the great increase in population demands the use of peat lands for the growth of crops and for various industrial purposes. But the very factors, however, which have brought about this great accumulation of vegetable material, and which constitutes a gain in land as against the loss upon mineral upland by erosion and leaching, may also introduce with them certain possible sources of failure. The great profits obtainable from the cultivation of truck crops may

lead to the use of certain kinds of peat land at the expense of other types of farming which would be less liable to failure or to dangerous limitations. The desire for rapid returns may not in a few instances encourage the landholder to ignore the wise rule of crop adaptation through crop rotation with suitable varieties; he may fail to heed the decreases in yield which follow a lack of knowledge of the different peat materials and their characteristics, especially the changes in conditions, such as the water table whose influence requires close and continuous study.

It would be well, therefore, to consider what is the position of Massachusetts in this matter of peat land utilization and what work should be done towards obtaining a fair degree of success in local areas with peat lands differing in material and in field conditions.

Several important elements enter into the problem under consideration, which for convenience are named (1) the influence of vegetation; (2) the influence of climate; and (3) the geological and topographic factors.

I. *The influence of vegetation.*

The native vegetation which covers the peat lands of today presents to the careful observer unmistakable features in regard to the predominating plant associations forming peat materials and the diversity of habitats which they reflect. Their various growth forms are correlated in the main with variations in the ground water table and they represent distinct effects in the method of building up strata of peat. Changes in the character of the indigenous vegetation of peat lands are as a general rule very slow under ordinary circumstances. This fact is so striking that the appearance of certain bog plants should serve the intelligent farmer not only as an index to environmental conditions and their products but also as a guide in the selection of his farm practice.

It is well known, however, that commonly the variations in peat materials over the surface area, and the nature of the sub-surface materials are rarely if ever examined in any detail, and are often entirely omitted from observation. Whether or not peat materials consist of layers of vegetable debris easily penetrated by roots of crop plants, by water and air so that they will weather, shrink and yet drain readily, or whether root penetration is limited by beds of material unlike in composition and degree of disintegration, such

as layers of plastic peat derived from aquatic plants or formed under periods of flooded and high water conditions; layers of granular material resulting from woody shrubs during periods of excessive drought conditions or following drainage changes; whether distinctions in the materials arise on account of strata of windfallen timber or of drifted impurities, such as ashes, silt, clay, or marl, the amounts of which depend on the currents of streams and rivers, their flooding power, etc.; whether plant growth and crop yield are influenced by a hardpan of fine-grained organic material or by one arising from compounds with lime or with iron; whether the contact layers of peaty material with a bottom of sand, gravel, clay, diatomaceous earth, or marl are continuous or not, and whether the mineral soils below, or those along the margins of the peat land, indicate predominantly solution and bleaching action or a deposition and "staining" process with mottled coloring,— all these points are of the greatest practical import. Marked physical differences arise from the several materials which undergo disintegration, in the relative abundance of that indefinite, fine-grained debris which plays the role in distinctions between heavy and light peat lands and which gives a certain degree of adhesive plasticity, but under some conditions render the surface peat soil almost impervious to water, probably due to the absorption of air.

The physical nature of the different peat and muck lands of the state and their respective substrata materials are doubtless of the widest practical importance, since it is in general more difficult to change the nature of the vegetable mass than to remedy the chemical deficiencies. Aside from the modifying influences of field conditions this is probably one reason why a chemical analysis of an organic soil is generally of little value in establishing relations to crop productivity. It is necessary, therefore, at least in somewhat more detail than undertaken hitherto, to understand the differences in the respective groups of peat lands, the phases of their materials and the field conditions under which they were formed. A profitable use of them can be made with related cultural methods and a choice of suitable crops. How important a detailed investigation may become to Massachusetts and for that matter to any other state, in view of the existing great geographical differences in climate, geology, and vegetational influences affecting the character

of peat lands and their agricultural and industrial possibilities, is readily apparent.

The role of vegetation in the conversion into peat lands of water basins or of wet depressions on uplands, along rivers, or at the coast has long been recognized, but the sequence of plant associations forming peat, the possible retrogressions, the origin and the conditions giving rise especially to ericaceous heath-bogs, and lastly the manner in which peat accumulation takes place are still problems at present under much discussion by investigators.

The general conclusions formed from one point of view lead, briefly stated, to the following: In common with other glaciated regions the origin of the modern era of plant life in Massachusetts dates back to the period when the continental glaciers receded toward the North pole and vegetation from the south and west once more migrated northward in the wake of the retreating ice sheet. During the time that has elapsed since the recession of the ice front, variously estimated at from 30,000 years for southern states to 20,000 years or less for northern states, many plant societies have doubtless occupied this region, which at the present time are characteristic of regions farther north. Thus the first vegetation to seize upon the areas which became exposed gradually may have been quite similar to the tundra of the far north, extensive, compact mats of herbaceous plants, and woody, prostrate forms, shrubby in appearance and chiefly of the ericaceous family. Following the tundra there developed slowly, it is presumed, a type of bog shrub stage and later one of temporary climax vegetation similar to the spruce and fir forests, which still comprise an important element on the peat lands of northern Massachusetts. Last of all followed in their northward march components from the southern coastal district, and from the plateau regions the deciduous and hardwood trees and their dependents, which at the present time predominate on the peat lands of such states as Ohio and Indiana.

Deciduous trees and some of the plants associated with them have now, that is within very recent geological time, regained only a position of their original home; they have commenced to invade this region and are establishing themselves in the more favorable sites, thus giving rise to a mixture of coniferous and deciduous forest type of peat lands, transforming them into a new and differ-

ent habitat. But the conquest of some of the former lakes, ponds, and inundated depressions along rivers and the coast is still going on and many of the isolated plant associations still survive as the remnants of a more northern type of plant succession. Coastal cedar swamps and river marshes are quite suggestive of this fact, for the cranberry sphagnum type of bog meadow described elsewhere as one of the members in the classification of peat lands (Ohio Geological Survey, Bull. 16, 1912), is of frequent occurrence as the ground mat where boreal, certain austral, and even several maritime plants may find conditions for growth and establishment. There is abundant evidence tending to show that southern plants seem to be gaining the ascendancy and that wherever suitable changes in drainage and weathering ensue, spruce, fir, tamarack, pine, and cedar become replaced largely if not entirely. Red maple, elm, ash, and others are contributing more and more to the increasing complexity of peat materials.

Very much of what we wish to know about the composition of peat materials, its variations and the effects of these upon crops depends, therefore, on the detailed study of profile sections of a peat basin; they recapitulate, so to speak, the history of its formation. There is a growing recognition of the injustice and the unbusiness-like character of treating all kinds of essentially different peat materials as being equal in quality and cropping value. It requires no argument to show that peat materials are of different composition and have different agricultural and industrial possibilities, but it demands considerable information and investigation to establish these differences scientifically and to show in what manner their agricultural and economic value is not the same. The physical constitution varies greatly according to locality and topographic features and even in the same field; a recognition of the controlling or modifying factors would emphasize to those using peat land the inherent limitations of the materials. This point is brought out clearly from any series of peat samples obtained in a profile sounding operation.

The lowest layer is frequently a plastic amorphous peat derived in the main from aquatic forms of plant and animal life (diatoms etc.), and from disintegrating floating organic debris of the marginal vegetation. When the accumulation of this material has reached

somewhere a height near the surface water the growth of marginal amphibious plants and following them a floating mat of herbaceous plants is made possible. Gradually this gives rise to a more or less continuous upper stratum of fibrous, felty or matted peat, later covering nearly the entire surface of the basin. The plants of the same association remain together and they become buried at about the same time, as a layer essentially intact. Another change in texture, structure, and composition of materials takes place when after sufficient settling and firmness, the accumulation of peat continues *above* the water table by the growth of ericaceous and other plants, commonly known as bog xerophytes. This type of peat material contains, as a layer, woody and leafy components unlike in their resistance to disintegration and dominant among which are certain waxy and resinous bodies. As the conditions which favor more effective weathering, and the action of bacteria and fungi improve in duration as well, they begin to support the growth of coniferous trees, or of a mixed forest, and later a deciduous mesophytic forest vegetation.

The organic debris is then chiefly formed from leaf fall and contains considerable amounts of soluble mineral matter brought to the surface by the activity of the roots of trees. Moreover the trees and shrubs contribute by their weight to a further sinking of the underlying fibrous mat; and by their shade the displacement of any surface herbaceous and ericaceous meadow-forms soon follows. Thus a more woody layer of peat makes its appearance, partly from windfallen timber, which takes on a granular texture as periods of drought and changes in the level of the ground water table permit the disintegrating and weathering processes to reach greater depths. Bearing in mind the great variety of topographic and other field conditions, which bring about fluctuations in the vegetation cover, or in drifted and in windfallen material, it is easily seen that many changes in peat layers and in their intergradations exist, so that it is not always possible to assign a given peat land and the series of its layers to any definite category of causal factors. Hence a careful study of the conditions which exist or may ensue as a result, for example of the depth, the number or character of drains, is one of greater importance than appears at first sight.

The main points, however, bearing on crop productivity of peat lands are the following:

(1) The composition of the horizontal and of the vertical strata of peat materials;

(2) the degree of disintegration, which is (likewise) dependent on (*a*) the character of plant associations that contributed to the deposit originally as well as at the present moment, and (*b*) the duration and effectiveness of drainage, the weathering processes and bacterio-fungal agencies under the existing field conditions;

(3) the shrinkage of the peat materials in relation to the water table to be established by drainage measures;

(4) the permeability of the materials for water, air, and roots of crop plants;

(5) the water content of the surface layer of peat soils when under certain crops.

II. *The influence of climate.*

Varied questions are raised by a consideration of the climatic factor combined with others due to the change in field conditions, in peat materials which partly accompany the sequence of peat forming vegetation, in the influence of weathering or leaching processes, or in the distribution of rainfall and variations in ground water table affecting peat lands.

The annual rainfall in the New England states ranges from 40 to 50 inches, the greater amount of which is precipitated during winter and in the cooler months of spring and autumn. This condition does not compensate for the loss by evaporation during the drier summer season and hence a more or less variable water level exists upon some peat lands lacking barriers than would be possible if the greater precipitation occurred within the warmer season of the year. On the other hand a relatively high and permanent stand of water prevails upon peat lands with natural ridges or with low gradient and where dams have been built or ditches have been neglected. The special climatic conditions under which Massachusetts peat lands have been forming render those with fluctuating changes in the water table and those with subterranean springs in need of more detailed study.

There impresses itself upon the observer a condition in the soil of certain uplands adjoining peat basins, the character of which deserves much thorough investigation. It is strikingly unlike anything observed in regional peat lands of a more continental

climate. A typical section taken under a forest cover or one of heath shrubs shows beneath the peaty humus a layer of leached-out, whitish gray sand of varying thickness and underlying it a characteristic yellow to rusty brownish iron-stained sand becoming lighter in color and fading into gray as the depth increases. Where the humus blanket has been denuded for one cause or another these bleached sands support a correlated heath vegetation resembling that of certain peat land areas. The soils appear to be unsuitable for ordinary farming practices.

Not infrequently the proportion of ferruginous constituents is found to be much more considerable along the margins of water-logged peat lands, while in other cases a bed of bog iron may occur at no great depth below the surface peaty debris. In the central portions of the peat land the iron salts in a precipitated form are as a rule not present. Before deciding on a drainage or utilization project it is important, therefore, to ascertain the location, area and thickness of the ferruginous layers and to determine the chemical nature of the constituents. In origin and formation they are post-glacial, i. e., a relatively recent contamination, and it is of the highest importance that their further development either as black sand, bog iron, or iron pan, should be checked by suitable remedial measures.

It is well known that under water-logged conditions, disintegrating organic matter and carbonated waters have a marked dissolving power upon minerals of rocks and soils and hence are very potent factors in leaching processes. Leached soils are comparatively poor in mineral plant constituents, especially in lime, potash, and iron salts; leached peat lands are usually acid in reaction, and require therefore fertilizers and the operations of liming or marling to produce the agriculturally desirable qualities of a fertile peat land. The humid climate of the New England states is very favorable to leaching processes and especially so in the presence of organic matter over porous sandy sub-soils. It appears that with the gradual increase in the mass of peat materials, accumulating since the glacial period on uplands and in lowland areas, widespread changes have been brought about from disintegrating peat by the waters which contained organic colloidal complexes in suspension and moved upward, downward or laterally, according

to circumstances through adjoining sandy areas. It is well known that much of the dissolved constituents from the upper soil layer is carried down by the seasonal rainfall and is commonly redeposited some distance below the surface soil, forming the "pan." The upper sand layers are then white or grey in color and very silicious, and where a surface layer of peat or humus is absent, the vegetation becomes more and more open, and dwarfed and heath-like. The land approaches the character of a "barren," since only plants with a shallow root system and with a low requirement of nutrition and growth appear to be able to thrive and mature.

With free drainage at deep levels, pan formation is rarely found. Investigations of European writers have shown how far-reaching is the influence of washing-out or leaching-out of the soluble constituents of the soil in climates of abundant seasonal rainfall. They have pointed out the desirability of avoiding fallows as much as possible, and of keeping the soil well occupied by crops, particularly hay and pasture grasses, certain staple crops, and root crops.

In the cases where seepage and ground water are not carried away by free drainage, the leached materials tend to accumulate in the soil and to cement the sandy substrata. During the drier season of the year the downward movement of water ceases; the groundwaters from the lower layers begin to move upward, and the soluble materials have then an upward tendency.

Periods of drought, strong winds, and consequent evaporation favor absorption and the deposition and concentration of iron and other salts in solution. The loss of any excess of carbonic acid from the underground waters, the presence of alkaline earth, or a substratum richer in soluble salts; the increased oxidation in the stratum on being exposed to the atmosphere, and the destruction of the colloidal humus complexes, which is partly accomplished by the action of bacteria,— any one or all of these factors may liberate the iron, alumina, magnesia, and others. These may form under certain conditions either nodules or concretions in the soil, or in some cases a continuous layer of considerable thickness. The solid aggregations vary widely in composition, in amount of fine-grained organic matter and in degree of cementation. Hence much importance should be attached to the character and color of peaty waters, the amount of suspended material which they con-

tain, to the direction of their transport and movement as percolating ground waters, and to the place of ulterior evaporation of these waters, e. i, the precipitation of their salts. It is needless to add that to the form of the surface drainage and the underdrainage system and to the effects of irrigation channels on the horizontal, vertical or lateral movement of such ground waters on peat land the greatest of care should be given.

Observations on peat lands with a water level 30 to 40 inches below the surface and which are not exposed to floods show that evaporation is relatively active during the summer season. This renders the surface soil when under cultivation liable to saline incrustations due to salt constituents of various kinds in solution drawn from the deeper beds. The action is strongly marked in ditches on peat lands with a water table fluctuating during the seasons for plant growth.

In deep and broad peat basins the imbibition and transport of soil waters is on the whole horizontal and dependent for its position upon those strata of peat materials whose composition and properties favor a lateral movement. This is readily observed in open ditches with peaty strata which permit underground water drainage along the cleavage lines and (upon estuarine peat land) which contain beds of diatomaceous earth or heavy layers of ash owing to severe and extensive clearing fires. The ash is chalk-like in color at the inner portions of the peat basin due to the removal of iron compounds to which the yellow and red ash at the marginal areas normally owes its color.

In shallow peat lands and those of small size and depth the transport of ground waters appears to be vertical and lateral. During floods, however, the abundance of water reduces the movement of the saline constituents and from the appearance of the characteristically bleached sands underlying the peat lands it may be concluded that the transport is then lateral and downward where under-drainage is free.

We are lacking data showing the increase in evaporation and vertical salt deposition due to specific crops, such as corn, potato, certain truck crops, and grasses for hay or pasture, but there is little doubt that onion would show an excess.

Fogs and other forms of humidity should be closely observed

since it may be regarded as probable that a considerably larger number of days with a water vapor blanket reducing low temperature in the critical frosty days of the growing period may result from the enhanced evaporation conditions consequent to the increase in cultivation. This may make the relative humidity conditions and therefore the duration of the growing period for crops more advantageous in certain localities with peat lands of greater depth of materials. But this question and others connected more chiefly with physiological effects of field conditions on crop plants demand a more thorough study than has been at present accorded to peat investigations.

III. *The geological and topographic factors.*

Owing to the solvent action of disintegrating masses of vegetable material a consideration of the underlying rocks and soils has therefore great importance practically as well as theoretically, because they are in many respects the causes of the more primary differences between marly alkaline to neutral peat lands and ferruginous and acid peat lands; they determine also in a great measure the degree of disintegration, leaching, and weathering of peat, and they condition the particular drainage measure, the choice of the crop system, and the cultural methods best suited to their respective peat materials.

According to the relief of the land Massachusetts may be divided into a number of physiographic provinces, each marked by its own characteristic topography and geologic belts.

In the western section of the state are the series of mountainous ridges of rugged topography, the rocks of which consist of strongly folded and faulted quartzites, limestones, slates, schists, etc., mostly of Paleozoic age. Of primary consideration is the fact that in the Berkshire Valley the peat lands of morainal lacustrine and of valley topography are generally underlaid by marl and similar calcareous substances.

The Connecticut Valley is marked in general by the presence of soft reddish Triassic sandstones and shales, with an occasional trap ridge. East of it in the highlands occurs a belt of folded sedimentary and metamorphic rocks and further eastward, gradually sloping toward the coast, is a broad crystalline belt consisting largely of metamorphic and igneous rocks, such as granites, mi-

caceous gneisses and others, both basic and acid, but including many altered sedimentary beds. In the vicinity of Boston and southward there are considerable areas of carboniferous sandstones, conglomerates, and slates.

The mantle of drift or till left by the glaciers masks and obscures the pre-glacial peneplain. The most characteristic forms of the glacial soils are the rounded hills of unmodified material known as drumlins, which show a tendency to linear grouping. The peat lands in their depressions are conditioned in the main by springs; but unlike those located along fault lines and issuing from rock crevices, the springs are intermittent and show their connection with the seasonal rainfall.

Another form of glacial drift are the plains of stratified sand which appear to be chiefly deltas and outwash aprons formed by streams during the successive stages of lowering of ancient glacial lakes. These sand plains may be regarded as the natural reservoirs of characteristically soft water, with a uniformly shallow water table. Peat lands occupying depressions in the stratified drift are well exemplified by the "Great Cedar Swamps," so abundant in the southeastern portion of the state. The great extent and the continuity of these sand plains has been one of the chief causes in the obstruction of former drainage channels and in the formation of those lake and river peat lands which today constitute the main peat resource of the state.

The till of the upland adjoining peat land is arenaceous, porous in texture, and supplemented with occasional interbedded and superficial layers of washed material. It readily absorbs the greater portion of the rainfall and is quite susceptible to the "podsoling" process mentioned above. Differences in this feature may be accounted for in part by the variations in the surface organic materials, in the texture and character of sub-surface mineral soils, and in the season's rainfall from year to year.

The till underlying the peat lands is prevailingly well compacted and probably is the principal source of supply as well as the factor determining the nature of the ground waters.

Beds of clay underneath peat lands are not numerous; they are found deposited at relatively low levels of elevation, and to some extent under the salt marshes and in the fresh water peat lands near the coast.

The rock formations and soils in the respective water sheds of the state and at the head of the main rivers arising there, are probably of no less importance in supplying the dominant mineral constituents of springs and groundwaters than the soils underlying the peat lands in the coastal plain section. The variations in organic materials of estuarine peat lands and the amounts of their inorganic impurities depend undoubtedly much upon the individual streams, their varying currents, flooding power, and the specific nature of the organic and mineral constituents carried in suspension. Consequently analytical work would naturally be of deep interest to those favoring the chemical side of the question in its relation to problems of fertilizer requirement in the improvement of peat lands.

However, it is still an open question whether the conditions are ripe for the closer chemical investigation which many soil students desire, except in those more extreme and primary distinctions between calcareous and ferruginous peat lands. Whether the chemical method would yield the results in any way as definitely correlated with the tilling qualities of peat lands and their agricultural or industrial value, as for example, ecological or bacteriological investigations, is a problem which warrants further investigation.

The main questions from the geological standpoint, which seem to require careful consideration are

(1) the character and the condition of the underlying rocks and mineral soils;

(2) the variations in and the nature of the ground waters at the various levels of the peat mass;

(3) the direction and the distribution of the salts during transport, especially along the lines of cleavage in the stratal ground water drainage, and their place of deposition.

IV. *Some of the uses of Massachusetts peat lands.*

There is today generally a greater interest in and a better appreciation of the advantages which peat land has over soils of other kinds in regard to cost of labor, ease of tillage, range, yield, and market of crops. Some of the factors for which the farmer is personally responsible and on which the permanent improvement of these soils largely depends, have been described elsewhere

(Journ. Amer. Peat Soc. 9, 10–21, 1915). There is need of emphasizing in this connection that much consideration should be given to the dangers from over-drainage and improper cultural methods.

As to fertilizer, either potash, principally the basic form, or manure should be used to begin the improvement of peat lands, but liming may or may not be advisable. The acidity of certain peat materials does not necessarily decrease their productivity. The only correct means, however, of determining the fertilizer requirements on peat land of specifically different peat materials consists in making actual growing tests and studying the reactions and the yields obtained. The use of manure is to be highly recommended, especially upon the heavy, compact phases of peat, which should receive the coarser manures. The value of fibrous peat material as a stable litter or bedding in stock and in dairy farming can hardly be over-estimated. Peat materials are known to absorb not only large quantities of water or of solutes but gaseous products as well. Owing to their great absorptive power peat materials are used as a deodorizer and as an efficient absorbent for gaseous ammonia formed from the decay of manure, which would otherwise escape into the air and be lost.

There is little doubt that the agricultural development of suitably prepared peat lands in Massachusetts would prove to be profitable. The cultivation of grasses and certain clovers for hay and pasture for a few years will probably be the safest operation. The pasture problem has been in the main neglected and hence it seems that it should be relatively advantageous to double the product. Moreover, the decrease in the number of head of livestock has been very great in all countries of late and a strong demand for both animals and their food is making itself felt.

But the peat lands of Massachusetts may well be utilized for other types of farming. Every effort should be made to eliminate this waste of peat land resources and to increase the food products of the state. Corn, preferably for silage purposes, potato, oats, rye, and clovers with grasses may be grown; they should be rotated every few years. Root crops to supplement pasture and used as succulent feed for stock in fall and winter on the farm would not only improve the plowed layer, but probably give fairly high yields. They should follow cereals such as rye, oats, millet, and

others. This list is not a large one, but that is mainly due to the fact that carefully conducted field trials to serve as practical demonstrations are quite essential in a state with peat lands differing in field conditions. Detailed investigations on crops with qualities of resistance, of rapidity in growth and maturity, capacity to yield suitable variations and related to specific peat materials and field conditions are still lacking from which to obtain reliable information. No less important is the greater utilization of peat lands for certain ornamental trees and shrubs and for much of the nursery stock and also for many bulb plants which are now imported from other countries with the dangers of disease infection. The peat lands of Massachusetts certainly compare favorably with those which have been so successfully utilized in Sweden, Holland, Germany, and other countries of northern Europe.

The use of peat materials for industrial purposes is constantly increasing; their place and role as stock food ingredient; their value as fertilizer dilutent or filler both with and without previous treatment or mixture with inorganic salts; their effectiveness as a carrier of bacterial inoculations; as fiber for surgical dressings, for special grades of paper, for carpets or for packing material; their value as granular, compressed or powdered peat; in the manufacture of producer gas and heating devices; the use of sapropel and ericoid materials for the distillation of tar and related products, for purposes of extraction of crude oil, ammonium sulfate, paraffin, wax or fuel gases; their effectiveness for hygienic and sanitary purposes such as peat baths and mud baths; for these and other uses peat materials are assuming considerable prominence commercially (see Bull. 16: Chapter IV, Ohio Geological Survey, 1912). It involves a knowledge of the peat materials and the removal and destruction of specifically suitable beds or strata, and therefore should be resorted to only in exceptional cases after detailed technical information has been secured. Of fundamental significance is the method of collecting the materials; this should not be done without reference to the fact that the layers of peat materials in a deposit are different in origin, composition, and properties, and in not a few instances may be entirely unsuitable for the specific uses referred to above. The economic utilization of peat materials, by far much more so than their agricultural usage, must base itself

upon a knowledge of the different kinds of peat materials and the factors in the field which conditioned their accumulation and character; hence their technical use should be treated as a rather highly specialized form of business, if the best financial results are to be obtained.

Considerable attention has been drawn of late to statements that an important and valuable effect of peat is in its value as a plant food,—i. e., in the presence of certain "accessory" organic food substances derived from bacterized peat material; very small amounts of it are thought to be sufficient to satisfy the needs of growing plants. This subject has been under investigation in Germany and in England. The action of these compounds, as yet undetermined chemically, is reported to have been variable. This no doubt may be due to the difference in character and in the conditions of the peat materials used in relation to the efficiency and the duration of action of beneficial micro-organisms. To bacteriologists the action of bacteria and fungi in converting certain organic and inorganic substances into a soluble form and to bind free atmospheric nitrogen is not a new problem. It is rather in the technical handicap of using peat materials as carriers which are free from objectionable qualities and in the development of satisfactory methods to maintain an active state of condition in the organisms yielding the requisite products.

If Massachusetts continues to forge to the front as she has done in her cranberry industry it will be through a recognition of the differences existing in field conditions of peat lands and in peat materials affected by them. This work may take much effort, but it can be accomplished through the state agencies now at work.

Conclusion.

The reconnaisance work on Massachusetts peat lands leads to the following general conclusions:

1. The inequality in the character of peat lands encountered and in the strata of their materials may render a more detailed study one of considerable advantage in their agricultural or industrial utilization and requirements.

2. It would be of special advantage should specific peat materials and field conditions be kept under observation where underdrainage is intended and where changes are being made in the groundwater table, so that the agricultural development may correspond with the existing field conditions and with the ensuing changes in the character of the peat materials.

3. Information concerning the seasonal variations in the water table, the nature of the salt constituents, and the circumstances in the field conditions which lead to the augmentation or diminution of soluble constituents is of prime importance, the effect of any accumulation of iron compounds especially requiring attention in certain cases.

4. The relation of cropping system to the several kinds of peat lands if ignored would be to the disadvantage of the real agricultural value of certain peat lands. Field trials are the more correct means under the existing conditions on the peat lands to determine the choice of crop varieties, seeding mixtures, etc., and the cultural practices to be followed.

HERBACEOUS PERENNIALS WE SHOULD GROW.

By Prof. Arno H. Nehrling, Amherst, Mass.

Delivered before the Society, with stereopticon illustrations, February 3, 1917.

I am happy to have an opportunity to address you on the subject of "Perennials we should grow" because it is a group of plants in which I am especially interested. For the last three years I have been devoting a great deal of time to the study of perennials and I do not think I have ever worked with a more interesting group of plants, and I wish to say at the outset, that herbaceous perennials unquestionably deserve the popularity which they are enjoying at the present time.

When we think of an ideal perennial garden we usually include the spring-flowering bulbs. Can you imagine our gardens without the dainty Snowdrop (*Galanthus nivalis*), followed by clumps of Crocus (*Crocus versicolor*), and the Showy Squill (*Scilla sibirica*) which open their flowers even before the snow has entirely disappeared? After these have passed away come constant changes in a well arranged perennial border every week. In fact, every day will bring forth something new to interest and delight the eye of the flower lover. Only severe freezing weather will put an end to such persistent late-blooming sorts as hardy Chrysanthemums, Japanese Anemones, New England Asters, Gaillardias, Aconitums, etc.

It is not my purpose today to treat the subject in a general way, because so much has been said and written of late concerning the management, planting, and care of herbaceous borders. I will be more specific and deal only with the perennials we should grow in our gardens. Before I take up the actual materials, however, let us trace briefly the evolution of gardening in this country from the time the Pilgrim Fathers landed on the bleak, barren shores of New

England, bringing with them a few seeds of garden pinks, and other old-fashioned garden flowers, to the present day.

When we study the history of gardening in America we find that many changes have been brought about from time to time, especially in the types of plants used in beds and borders for ornamental purposes. These changes might be termed fashions in plants. The most important change occurred with the introduction of the so-called bedding plants at the time of the Centennial Exposition in Philadelphia in 1876. These showy plants appealed strongly to the public and from that time on the so-called old fashioned flowers which our grandmothers had been growing with good results for years and years, came into disfavor with the gardener, especially the home gardener. Even twenty years ago there were few borders outside of those planted by professional gardeners on private estates and in public parks.

With the adoption of the naturalistic style of landscape gardening a decided change occurred not only in the type of materials used, but also in the manner of planting, and the last ten years has seen a growing interest in the so-called old-fashioned hardy plants which are technically known as hardy herbaceous perennials, and never have they been so highly esteemed as they are at the present time. Everyone who is fortunate enough to have even a small garden should devote at least part of it to hardy plants.

The reasons for this popularity are obvious. First of all, they are plants that live from year to year. Although the tops die off at the end of the growing season, new growths come from parts underground the following season. This of course gives the garden a feeling of permanency and by selecting the proper varieties the disappearing flowers will be continuously replaced by new ones. The colors of the varieties must be carefully studied as the color scheme is one of the primary features of the garden. The season of flowering must also be studied in order that the plants may be arranged so as to avoid clashes in color and so as to have an equality of flowers over the entire season. Even though the border is planned with utmost care, it is not always possible to have the entire border a mass of color throughout the season, and as already stated, in planning the perennial border a few clumps of spring-flowering bulbs such as Snowdrops, Scillas, etc., and masses of

annuals should be added. Annuals have a particular charm because quick results may be obtained with them, and although they are secondary in a border, they are nevertheless of vital importance in making a successful garden.

Another reason for the popularity of perennials at the present time is because of the fact that great improvements have been brought about by our nurserymen and plant hybridizers. We have much finer and many more varieties for planting than had our predecessors. It is only when a comparison is made between Delphinium, Paeony, Phlox, Asters, etc. of today with those in general cultivation ten or fifteen years ago that one realizes the extraordinary improvements that have been made.

Summing up the reasons for the increasing interest that has been taken in the cultivation of hardy herbaceous perennials the past few years, we must not overlook the fact that they are planted for effects to cover a period of years. Then too, there is no group of plants more adaptable to varied conditions of soil and location. While the majority of species prefer a good deep soil and an open position, there are a number which succeed under partially shaded conditions, and soil heavy and light, or moist and dry. Although they thrive best in the flower garden proper, there are a few which will grow better planted in the rockery, shrubbery border, or the wild garden. I might add at this point that men who are familiar with the construction of gardens have made the statement that the year 1916 went down in the history of gardening as the year of the the true beginning of rock gardening in this country. The interest in this type of gardening was stimulated to some extent by the fine displays of rock garden plants at the exhibitions throughout the land the past season.

Professional gardeners and amateurs have long ago come to the conclusion that the perennial border has passed the experimental stage and is now an important feature in every modern flower garden. From a well-planned garden or border is derived a feeling of quiet and rest that no amount of showy bedding plants such as red Geraniums, yellow Coleus, or Scarlet Sage can give us. By making the proper selection, any garden can be made attractive from early spring until fall.

Coming to the species and varieties we should grow, we now

have a splendid list from which to make selections. Many of our progressive firms have gone into the culture of perennials on a large scale. The Palisades Nurseries, Sparkill, N. Y., list over a thousand species and varieties. Henry A. Dreer, Philadelphia, R. & J. Farquhar, Boston, Bertram Farr, Wyomissing, Pa., A. N. Pierson, Cromwell, Conn., Knight & Struck, New York City, and many other progressive florists and seedsmen offer large collections. However, the number of species and varieties does not compare with the number grown on the other side of the water where this group of plants has always received a great deal of attention. Mr. M. Free, the superintendent of the Brooklyn Botanic Garden in an article in the Florists' Exchange, March 26th, 1916, makes the following statement with reference to the number of species in cultivation in this country, compared to the number used in England.

"It must be generally admitted that our perennial borders, with some few exceptions, are characterized by a great lack of variety in the plant material used. Especially is this noticeable when comparisons are made with the hardy flower borders of several European countries where the culture of herbaceous plants in borders and rock gardens has assumed enormous proportions. In the Royal Gardens, Kew, over 8000 species and varieties of herbaceous plants are grown, and it is no uncommon thing to see catalogs published by nurserymen containing over 2000 varieties. While not advocating for an instant the growing of plants simply for the sake of having a large collection, it must be conceded that when a nurseryman catalogs 2000 hardy plants, there must be a number of really meritorious subjects which are not grown in our borders, and which are not to be found in the lists published by the majority of American firms dealing in hardy plants.

"The demand for, and importance of, hardy perennials is increasing by leaps and bounds. People are getting tired of the monotony and expense of formal bedding and demand a return to the old-fashioned perennial border which, when properly constructed, provides plants in bloom, of some kind or other, from April to November. It is up to the nurserymen therefore, to see that this demand is supplied. The man who is able to do this is the one likeliest to reap the largest profits. We will have to break away from the stereotyped list of plants that everyone who grows

herbaceous plants already has in his possession and launch out in introducing new plants. Novelties are a necessity, not only from the interest they generate, but from the point of view of the matter of hard cash involved."

The English firms who specialize in hardy plants realize the important psychological fact that people are always seeking something new, and strenuous efforts are constantly being made to add new plants to their collections. The majority of the new sorts are obtained by cross-breeding standard varieties. Others obtain their novelties by sending expeditions for the purpose of collecting new plants in their native habitats.

Our own Mr. Wilson has brought to this country a large collection of trees, shrubs, and herbaceous plants, among the latter being Liliums, *Buddleia variabilis, Aconitum Wilsoni, Anemone hupehensis, Artemisia lactiflora,* etc.

Even though our brothers across the water are offering a larger number of species in their catalogs, we have at the present time a vast amount of material to choose from. The range of color in these plants covers a wide range of tones. Mrs. Francis King in her work on "The Well-Considered Garden" says, "Never before were seen pinks of such richness, such deep velvet-like violets, delicate buffs and salmons, actual blues, vivid orange tones, and pale beautiful lavenders." Through the magic of the hybridizers we are today without excuse for ugliness in the garden.

The question of color, if good effects are to be obtained, is an important one, and should be considered seriously when materials are being selected. The average descriptive seed or bulb list is not always as accurate as it might be. We have as yet no color standard for garden flowers. Mrs. Sedgwick in "The Garden Month by Month," provides a chart which is of great value in the selection of plants for a perennial garden. It is rather difficult to make definite recommendations regarding color selection because of the likes and dislikes of the individual. Most of us have prejudices against a certain color and disregard it completely when selecting material. This same color, when judiciously used with correlated tones, may have been transmuted into a perfect picture. The successful gardener must also be somewhat of an artist and have a keen eye for color effect, whether the scheme is one of contrasts or a gradual verging from one shade to another.

On some of our larger estates entire gardens or portions of a garden are devoted to plants of one color, such as blue, red, or white. The blue garden has been especially popular of late.

Again, coming back to the actual problem of the herbaceous perennials we should grow, let me say that in a list of 100 of the best sorts, few people agree as to which actually are the best subjects for a particular purpose. The personal element will again be an important factor in making a choice.

My recommendations will be based on tests which have been made the past three seasons in the perennial garden at the Massachusetts Agricultural College. Our collection, although far from being complete, contains at the present time over 500 different species and varieties. They are planted in beds 12 × 50 feet separated by grass walks, one row of a variety with six plants in a row. This garden has not been planted from the standpoint of artistic effects, but principally for study, all plants being provided with zinc labels.

I will not weary you with a list of all the meritorious hardy plants, but select only those which are the most useful among those we should grow. The writer has endeavored to put aside his own likes and dislikes, and included only the more satisfactory forms. There are many more sorts with strong claims of inclusion, but as our time is limited, the exclusion of many good things is inevitable.

The plants I will mention have been placed in their approximate order of flowering and there will of course be cases of overlapping throughout the season. In the period allotted to me, it will of course be impossible for me to mention the specific use of each form, however my slides will, I hope, illustrate these points to some extent.

I might classify the plants I will mention and state definitely for what position in the garden they are most satisfactory; however, since this is impossible in a short period, I have arranged the plants as to the season of flowering, height, and color of the flowers.

A collection could be selected to good advantage from the following list:

APRIL–MAY

Name	*Color*	*Height*
Arabis albida	White	6–8″
Alyssum saxatile compactum	Yellow	9–18″

Name	*Color*	*Height*
Phlox subulata	Pink	6″
Anemone pulsatilla	Light blue	9″
Veronica gentianoides	Blue	1–2′
MAY–JUNE		
Doronicum platagineum excelsum	Yellow	1½–2′
Aquilegia caerulea	Light blue and white	1½–2′
" glandulosa	Blue and white	1′
" chrysantha	Yellow	2–3′
" canadensis	Scarlet and yellow	1½′
Dicentra spectabilis	Rose	2′
Iris germanica vars.	Various	2–3′
Dianthus deltoides	Deep pink	9″
Pyrethrum hybridum	Various	1½–2′
Lychnis viscaria splendens	Pink	1–1½′
Veronica amethystina	Deep blue	1–1½′
Aster alpinus	Purple	9″
JUNE–JULY		
Papaver orientale	Scarlet	2–3′
Paeonia	Various	3′
Lupinus polyphyllus Moerheimi	Pink	3′
Dianthus plumarius "Her Majesty"	White	1′
Hemerocallis flava	Yellow	3′
Polemonium Richardsoni	Blue	1½′
Helenium Hoopesii	Yellow	3′
Delphinium hybridum	Blue	4–5′
" belladonna	Pale blue	4–5′
Hemerocallis Dumortieri	Yellow	1½′
Baptisia australis	Dark blue	3′
Pentstemon laevigatus digitalis	Lilac white	2½′–3′
Dictamnus albus	White	2–3′
Aconitum Napellus	Deep blue	2½′
Anthemis tinctoria Kelwayi	Yellow	3′
Anchusa italica Dropmore	Blue	4–5′
" " Opal	Light blue	4′
Campanula persicifolia	Blue	2–4′
Coreopsis lanceolata	Yellow	2–2½′
Campanula carpatica	Blue	9″
Oenothera missouriensis	Yellow	1′
" fruticosa	Deep yellow	2–3′
Heuchera sanguinea	Red	1–1½′
Veronica incana	Blue	1–1½′

Name	*Color*	*Height*
Iris laevigata (Kaempferi)	Various	2–3′
Spiraea Aruncus	White	3′
Silene orientalis	Pink	1–1½′
Polemonium caeruleum	Blue	2–3′
JULY–AUGUST		
Hemerocallis aurantiaca major	Orange	3′
Delphinium grandiflorum	Blue	2½′
Armeria maritima splendens	Rose	1′
Campanula latifolia macrantha	Purple	3′
C. glomerata dahurica	Purple	2′
Gypsophila paniculata	White	2½′
Aster amellus bessarabicus	Blue	2′
Heliopsis laevis Pitcheriana	Yellow	3′
Lilium tigrinum splendens	Orange	4′
Lysimachia clethroides	White	2½′
Pentstemon barbatus Torreyi	Orange scarlet	4′
Geum chiloense "Mrs. Bradshaw"	Crimson	1½′
Gaillardia aristata	Yellow and red	2′
Monarda didyma	Bright red	3′
Physostegia virginiana	Rose purple	3–4′
Platycodon grandiflora Mariesii	Blue	1½′
Potentilla hybrida "Miss Willmott"	Cerise	1½′
Asclepias tuberosa	Orange	2½′
Stokesia cyanea	Blue	1′
Centaurea montana	Purple	1½′
Saponaria officinalis	Pink	1–1½′
Lythrum salicaria roseum superbum	Pink	4–6′
Astilbe Davidii	Deep pink	2′
Buddleia variabilis magnifica	Lilac	3–5′
Lepachys pinnata	Yellow	3–4′
Phlox glaberrima suffruticosa, var. Miss Lingard	White	2–3′
Sidalcea candida	White	2–3′
Centaurea macrocephala	Yellow	3′
Galegia bicolor Hartlandi	Pale lavender	3′
AUGUST–SEPTEMBER		
Phlox paniculata vars.	Various	2–3′
Scabiosa caucasica	Pale blue	1½′
Sedum spectabile roseum	Rose	1½′
Chrysanthemum maximum King Edw. VII	White	1½′
Rudbeckia speciosa	Orange yellow	2′

Name	*Color*	*Height*
Funkia subcordata grandiflora	White	1½′
Rudbeckia sub-tomentosa	Yellow	4′
Veronica longifolia sub-sessilis	Deep blue	2½′
Helenium autumnale superbum	Yellow	4–5′
Helenium "Riverton Gem"	Dark red	3′
Echinacea purpurea	Reddish purple	3–4′
Liatris pycnostachya	Purple	3–4′
Rudbeckia laciniata fl. pl.	Yellow	5–7′
Hibiscus moscheutos varieties	Various	4–6′
Achillea ptarmica "Perry's White"	White	1½′
Aconitum autumnale	Blue	3′
Helianthus multiflorus fl. pl.	Yellow	4′
Lobelia cardinalis	Red	2½–3′
" syphititica	Blue	3–3′

SEPTEMBER–OCTOBER

Solidago rigida	Yellow	3½′
Salvia azurea grandiflora	Pale blue	3–4′
Aconitum Fischeri	Blue	2–3′
Aster novae-angliae rosea	Rose	5–6′
Boltonia latisquama	White	4–5′
Aster novae-belgii "Perry's Pink"	Deep pink	3–3½′
Aster tataricus	Purple	5–6′
Anemone japonica	White	2–3′
Aster turbinellus	Light blue	3′

RECENT TROUBLES WITH OUR FOREST TREES.

By Frank W. Rane, State Forester of Massachusetts.

Delivered before the Society, with stereopticon illustrations, February 10, 1917.

The John Lewis Russell Lecture.

We are inclined to think that originally, before our forefathers discovered these shores, America was a country largely covered with magnificent forests which had stood unmolested for centuries upon centuries and were absolutely free from all sorts of depredations particularly insects and diseases. These conditions apparently prevailed also throughout our pioneer days in every section of the country, and it is only within recent years that our real forest and tree troubles have come upon us.

As long as the normal conditions prevailed the balance of nature was preserved and there was little trouble, but with so-called development through the agency of man, complicated conditions have arisen. We have not only been cleaning up forests and utilizing the land for agriculture, which is a legitimate undertaking, but we have been recklessly allowing indifference as to future conditions until today we are beginning to reap the results. In the struggle for existence of all kinds of vegetation, particularly forest trees which are trying to exist in every condition possible excepting their normal environment, is it any wonder that they have become susceptible to all kinds of troubles?

Forest fires alone have been allowed to run rampant over our slashings and forest tracts, laying waste great expanses of territory and destroying the leaf mould and reservoirs of plant food which, had they been preserved, might have given growth to sufficient forests in the future to supply a growing nation with all the forest products it could possibly use. With the changing environment of

forests and trees, likewise has come the unbalanced conditions of animal, bird, fish, and insect life, as well as the more favorable conditions for the development of various possible plant diseases.

It is evident to the student of plant life that the above named conditions are sufficient to lead us to expect in time troubles for our forest trees, but when to this condition we add the innumerable diseases of plants and insects that have been imported from foreign countries, the whole situation becomes indeed complicated. It naturally follows that in the older sections of the nation like New England in particular, we are among the first to be affected. Here conditions have apparently reached the climax. Realizing that our future depends upon a better and more constructive agriculture and forestry our people in Massachusetts at least are awaking to a realization of the conditions which confront them.

We have been steadily but surely perfecting a state forest policy for the past ten years and while the results are not as apparent to the casual observer as we wish they were, nevertheless, like the boy who was flying his kite above the clouds, although he could not see it, he knew it was there by its pull, so in the forestry work the pull is there in Massachusetts and now and then we have the pleasure of seeing results. Every ten years we predict will revolutionize our former conditions. What Germany has accomplished in centuries from a wise forest policy we should be able to accomplish in Massachusetts in a far less time. May we not all have an active part in such a laudable undertaking?

In forest troubles we include a very large number of depredations, the more important of which are damage to forests from fire, disease, insects, wind, and animals.

In a comparatively new country like ours where practically no attention was given to future conditions, and where due consideration of them is gained only by severe experience, we awaken to find many disastrous things have been done which now must be rectified. The problems now are many and complicated, and they could have been avoided with comparatively little effort, if we had had our present knowledge.

In forest troubles coming from insects and diseases we are finding, as was the case in the fruit-growing industry, our greater troubles come from introduced or so-called foreign insects and diseases

brought to us usually on imported stock. Steps have been taken to regulate future importation through careful inspections and powers of restriction, but this is of little use in overcoming and neutralizing the depredations of those already established. It is these insects and diseases that are causing us a great amount of trouble. To cope with these unwelcome guests has proven in many cases extremely troublesome and expensive.

The writer has had much experience with forest depredations and the results secured through a careful study of utilization as a practical aid in the solution of a few of our forest troubles in Massachusetts seem very encouraging. This probably explains why the secretary of this society has asked the writer to discuss at this time recent troubles with our forest trees. I shall take up first the latest developments in the work of suppression of the gypsy and brown-tail moths in Massachusetts, and, second, the present status of the chestnut blight and the blister rust diseases of more recent years, and allude more briefly to other troubles.

In order to succeed in aiding the woodland owner in our state in his fight against the invasion of his forest growth by pests, a very careful and complete survey of the whole question of markets, materials, labor costs, cost of teaming, transportation charges, milling expenses, supervision, etc., was made in order to utilize all dormant capital in forests where possible, which otherwise would be almost a total loss. This study has proved worth the effort as not only have we been able to make the sale of forest products self-supporting, but in many cases a substantial net revenue has been secured.

For a number of years the gypsy and brown-tail moth work was confined largely to shade-trees and orchards, and the work of combating and suppressing these insects was directed towards overcoming the great loss following their ravages measured largely in aesthetic values.

As was inevitable, although the very best brains of the nation, assisted by experts from abroad, were focused upon the suppression of these insects, the spread continued throughout the forests of the eastern part of the state. As these insects became intrenched in our woodlands, which are composed of a great variety ranging from valueless scrub and brush growth to superior stands, the same

methods practiced upon preservation of trees in cities and towns were prohibitive on account of the great expense entailed. It was found that to spray an acre of woodland of average conditions, with arsenate of lead for example, would cost forty dollars, while the assessed value of the whole property might not average that amount.

Anticipating these conditions the Massachusetts State Forester set at work to meet the situation, and in a year's time evolved a spraying machine that revolutionized all previous methods. This machine was constructed of parts made of bronze metal instead of cast iron and perfected in such a way as to obtain efficiency in spraying and at the same reduce the expense of operation. The result of this improvement in our spraying equipment was to lower the comparative cost of woodland spraying from forty to six dollars per acre. In accomplishing this result the Forester desires to acknowledge the assistance of L. H. Worthley and Melvin Guptill. The former was an assistant in the department, in charge of moth work, and the latter was responsible for executing the engineering work. This powerful machine, making possible the spraying of tall trees without climbing, is economical of team and manual labor. No patents were ever applied for, and the results were given to the world. This machine has been in common use in Massachusetts and elsewhere, and aside from the natural improvements suggested from experience, and minor inventions each year, is the same machine.

Other methods of moth suppression besides spraying have been used, such as introducing parasites, creosoting egg masses, etc., all of which are of value when used intelligently, but spraying is commonly resorted to when immediate results are desired. During the past season the contract for arsenate of lead by the State Forester was for seven hundred tons, and it is believed that one thousand tons may have been used in Massachusetts.

As soon as the moths began to make inroads upon the forests we were confronted not only with improving and perfecting our spraying methods, but other economic methods suggested themselves. It was found to be a poor policy to spray good, bad, and indifferent trees alike. It naturally followed, therefore, that the undesirable ones were taken out, thus enabling the remaining trees to be sprayed

more economically. Herein lies a point to be emphasized, namely, forest utilization in connection with depredations. The chief purpose of the forester is to bring order and system out of chaos and meanwhile to determine ways and means of reducing our methods to scientific and economic practice. Upon studying the moth situation from the broad standpoint of future results when applied to forest conditions, the correct method of procedure was self-evident. As already indicated, it was an advantage to thin the forests for better spraying, and this practice naturally fell to the trained forester.

As soon as modern forestry practices were applied and sylvicultural studies made, better results followed. It was soon demonstrated that certain trees were the natural food of the moth, while others were to a greater or lesser extent immune from their attack and particularly so when in so-called clear stands or in mixtures with other species equally undesirable as moth food.

Taking advantage of these fundamentals and encouraged by actual results from the field experience, the so-called forestry methods of moth control have rapidly come to the front. During the past few years the State Forester has executed some large forest operations which have not only proven satisfactory in handling the moths, but from the economic standpoint have aided in establishing better forestry practices. The result of moth infestation in woodlands was to throw upon the market an oversupply of dead and dying forest products.

The forests of Eastern Massachusetts are the remains of a culled-out and cut-over country which has restocked itself without regulation or control. All sorts of forest types, species, mixtures, ages, and conditions are found. When the moths invade these woodlands they readily find enough of such species as they prefer to live upon until they are fairly grown and then, if compelled to do so, they finish their feeding period on whatever remains for them to devour.

Taking advantage of this fact we have inaugurated the practice of taking out those species upon which the insects thrive best, their so-called natural food trees, with the result that the conditions are unhealthy for their propagation. The evergreens, the white pine in particular, one of our most valued species, we find is

practically immune from the gypsy moth when grown in clear stands, for the reason that the very young caterpillars are unable to eat its needles. Hence if there are no deciduous trees present upon which they may feed during earlier stages of existence the pine is unmolested. Had this fact alone been known earlier in the moth suppressive work, great areas of white pine could have been saved. Our present treatment, therefore, with white pine stands is simply to thin out the growth upon which the gypsy moth naturally feeds, such as oak and gray birch, and the stand is thereafter self-protecting.

To work out a policy whereby all of the various conditions and methods could be made to harmonize and still accomplish results has been no small undertaking. The earlier moth work entailed great expense and this in itself rendered it unpopular. The constant aim at present is to conduct the work along self-supporting lines as far as possible. In forestry methods of moth control, estimates of costs are made and the forest products practically sold before the operation is begun. The State Forester and his assistants supervise the work, let contracts for the milling, chopping, hauling, etc., but the owner advances the funds for the undertaking.

During the past three years approximately forty-five thousand cords of wood and between seven and eight million feet of lumber have been operated under this plan. Every time an operation of this sort is properly done it is not only an example of good moth suppressive work, but a beginning of better forestry practice; the territory for future infestation is lessened by just that much, and, best of all, it is self-supporting. Anyone can spend money in this work, but it takes men with experience and ability to break even, or, still better, return a profit to the owner.

To find a market, or utilization alone, has been a perplexing problem. It has been necessary to actually create a market for our products. The wood-using industries had well established sources of supply and many ingenious plans were attempted before the trade could be interested. Three years ago, under very unfavorable markets, the work was made a success, and since the European War, of course, the only difficulty to surmount is that of getting efficient labor. The demand for forest products is far beyond our ability to supply.

Word has been sent out recently from the Massachusetts State Forester to all farmers and woodland owners through his local town officials and by means of the press, emphasizing the fact that this year offers exceptional opportunities for doing splendid constructive forestry work. The price of coal is very high and should present conditions continue even more direful need for fuel may exist another season. At any rate everything is favorable for the better solving of our moth troubles and establishing permanent forestry conditions.

This whole subject is discussed more fully in the publications of the Massachusetts State Forester which are available to those interested. I trust I have pointed out that utilization, particularly in our fight in the moth control work in Massachusetts, has been a very practical method of attack. This work will necessarily need to be continued for years. If the gypsy and brown-tail moths have done nothing else they have driven us to a stern realization that we need to practice more and better methods of forestry management if we are to get best results.

Chestnut Blight.

The disease known as the Chestnut Blight has swept over the northeastern part of the United States and apparently stands ready to annihilate the chestnut tree in this section. It is common to Massachusetts generally, although in some sections of the state, conditions are worse than in others. As the disease is communicable from tree to tree, and is very virulent, the outcome is entirely problematic.

As is the case with moth work, Massachusetts is giving all possible aid to chestnut tree owners in utilization of their products and at the same time is determining upon some forestry policy for the cut-over land. Where the chestnut is in mixture of pine, the pine is retained with the idea of supplanting the chestnut growth with this species. Chestnut poles, ties, and saw timber are all in demand at good prices; hence conditions are very favorable for owners to realize on this crop.

White Pine Blister Rust.

This disease has been introduced into this country on nursery stock of either the white pine or other five-leaved pines, or on the currants and gooseberries, the plants belonging to the genus Ribes. Unlike the chestnut bark disease it does not spread from pine to pine, but must alternate from pine to Ribes to complete its life cycle.

The disease is common in Europe and was found in New York State on imported stock several years ago. At that time, upon the invitation of Mr. J. S. Whipple, then Forest, Fish, and Game Commissioner of New York, a conference of officials from various states and the government met at Albany and later in New York City, where the whole matter was fully discussed. The result of these meetings was to cease importing foreign white pine stock, rigidly inspect all future imports, grow our own stock in this country, and practice a close inspection of all foreign stock already planted here with a view to destroying it should the disease appear.

Recognizing the importance of making an inspection of the foreign stock already planted in Massachusetts, the State Forester had an official representative of the Bureau of Plant Industry of the United States Department of Agriculture visit our plantations and advise us regarding them in 1911.

Last year the disease was found on two of our large private estates, one in the eastern or North Shore section, and the other in the western or popular Berkshire country. Upon finding these outbreaks interest was aroused in determining more fully the conditions generally. It was found that the currants proved a good index for determining the presence of the disease, and an inspection over a considerable portion of the state showed it to be generally infested. Believing it of sufficient importance to make even further investigation desirable in order to determine more fully to just what extent the disease may be found and to eradicate its evils, the state appropriated ten thousand dollars for use the past season. The United States Congress also appropriated fifty thousand dollars for similar use throughout the nation.

Scouting investigations have continued throughout the year

and practically the whole State of Massachusetts has been covered. It is understood that the disease is found very generally distributed over the state, being, however, more commonly found in some sections than in others.

White pines are far less affected than are currants, but here and there the pines are found to be infected with the disease. In no case, as far as the writer is aware, is there an infection of sufficient magnitude to destroy a stand of white pine of any appreciable size. Here and there, where the disease has been present for a period of years, a few fairly good-sized trees ranging up to twelve inches in diameter contained more or less blister rust cankers on their branches and some upon the upper main trunk. In most cases here, however, the trees themselves were growing in abnormal conditions and were equally unhealthy from an unfavorable environment and were afflicted with all the other diseases and insect enemies common to their kind.

In plantations of imported stock the disease is likely to be found, and in our younger plantations, if the disease is present, it is in all likelihood accounted for in this way. Plantations of native stock are practically free from the disease. There is a possible danger, however, from these native plantations having been filled in with foreign stock, which might account for some infestations.

Our Massachusetts plantations of foreign stock have been gone over each year and the infected trees have been pulled and burned. This practice, now running over a period of six years, has resulted in less and less infected trees each year, and at no time has the percentage of trees affected been as large as one per cent.

With our present knowledge of the subject, what remains for us to do in the future? The writer is willing to state that it is his belief that more harm than good has been done by the unnecessary agitation in the publicity campaign so systematically carried on at great expense, exciting people over a subject about which enough is not yet known even by experts themselves. It is a very easy matter to tear down, but quite another to build up and accomplish something. For the past ten years we have been working hard in Massachusetts to encourage better forestry practices and reforestation, particularly with white pine, has just made a good start. Our people are interested and enthusiastically coöperating. We

have millions of trees in our nurseries ready to go out, and all at once under the guise of public-spirited coöperation, and before there has been sufficient evidence, a campaign is set in motion to discourage and thwart all our laudable reforestation endeavors.

Realizing that the blister rust disease needs attention, and believing that our forests could be properly safeguarded by those who are made responsible for so doing, last year the following recommendation was made in the State Forester's annual report, and it is believed it will bear repeating now as follows:—

"The White Pine Blister Rust," one of the diseases of the white pine, should be given due consideration at the hands of our various state officials, particularly the pathologist of the Agricultural Experiment Station and the State Nursery Inspector, in determining our conditions as regards this disease. Some definite policy of holding the disease in check, or exterminating it if possible, should be adopted. It is believed that while this disease may become very destructive to our white pines, nevertheless the danger is not sufficient to discourage prospective planters of the white pine. It is not our purpose to minimize the importance of this disease, nor do we intend to lessen our endeavor to combat it. We do, however, believe it is a good policy not to over-exaggerate the danger and thus necessarily deter the constructive work of reforestation, until there is more convincing proof than is to be had at present that the disease is likely to become a great menace to white pine. It is to be hoped that the average Massachusetts citizen will continue planting white pine as enthusiastically as ever, leaving the problem of its protection from diseases and insects to be looked after by technically-trained officials."

We certainly have not sufficient knowledge at the present time to determine how serious a situation confronts us in this disease. Investigation and experience will have to serve as a guide to future operations. From a more or less careful study of conditions my personal recommendations for handling this disease for the coming year would be as follows:—

1. Empower a state department with authority to regulate and control any and all diseased white pines and Ribes (currants and gooseberries), declaring them a public nuisance and to be dealt with in a similar manner to that in which gypsy moths are now controlled.

2. Make a sufficient appropriation for carrying the work on as the exigencies of the occasion demand from year to year.

Results are what are desired, and the sooner this disease is controlled the better. Meanwhile optimism rather than pessimism will the better aid in solving our forestry problems. Where there is a will there is a way, and Massachusetts does not concede for one minute that we are going to lose our white pines, from any diagnosis that her State Forester at least can make thus far.

White Pine Aphid or Mealy-bug.

This insect is quite common throughout Massachusetts on the white pine. It is easily recognized as it is covered with a white cottony substance very similar to other species which most everyone has seen upon greenhouse or house plants at some time or other. This insect occurs on the smooth bark of young trees or on the new growth of older trees where it lives by sucking the sap. The real damage to the tree comes when these insects are very numerous. Like all aphids they multiply very rapidly under favorable conditions. White pine trees are occasionally found that are badly infested. In recent years these insects have gotten into forest nursery stock to more or less of an extent, and it is very desirable that infested stock be treated before planting. These insects while they are found upon perfectly healthy stock nevertheless are far more prevalent upon trees that are more or less abnormal from one cause or another. Trees that are weakened by overcrowding or stunted by lack of sunlight, etc. are usually infested with Chermes or the white pine aphid or mealy-bug.

During the season of 1914 this insect became quite prevalent in Massachusetts on white pine and did a great amount of damage, but the two past seasons apparently have not been so favorable for its development. That this insect is well worthy of attention is true particularly in keeping it out of young pine plantations by insisting upon clean stock. It has natural enemies and it can be controlled by spraying, but a little foresight and better forestry methods of culture will go a long way towards overcoming its depredations.

The Forest Tent Caterpillar.

This insect is closely related in its habits to the ordinary orchard or apple tent caterpillar which is known to everybody. It, however, does not build a large tent and further it has as its name implies a greater variety of foods and prefers the forests for its ranging grounds. It eats oaks, maples, ash and other deciduous trees as well as the leaves of fruit and shade trees. These insects strip whole areas of hardwood forests occasionally in like manner as the gypsy moth. They have been quite prevalent in localities in recent years in this state. They are native insects, and their natural enemies have a tendency to keep them in check. Spraying as for gypsy moths is effective.

The White Pine Weevil.

This is the insect that is responsible for destroying the leader in young white pine trees. It is very destructive causing the young pines that come up in the open pastures to become very limby and hence make poor merchantable lumber when mature. In young plantations they are often very destructive. The past season was one of the worst we have experienced for this insect.

The adult insect is similar to the plum curculio in appearance only much larger. It lays its eggs in the terminal shoot. These eggs hatch and live as larvae or grubs in this shoot until they are fully grown and have done all of their eating. They then change to the beetle form and deposit eggs for future generations. This main shoot should be cut or broken out while the grubs are working therein and burned, thereby destroying future generations. This insect is native but with our decreasing natural stands of white pine they become more concentrated upon our remaining area. Our plantations of young white pine should be gone over each year while the leaders are easily gotten at. Pruning and thinning with an idea of forest improvement of course will aid in overcoming the work of this insect.

Pine Tree Blight.

This disease of the white pine which was very prevalent throughout the season of 1907 has made its appearance again during the past year in many sections of Massachusetts. Its chief characteristic is that the tips of the needles turn brown and die. Some trees show the malady more than others, depending upon just how far down the needles from the tip the so-called "blight" has spread.

It is believed there is little that can be done for the trees thus affected as it is evidently climatic conditions in all probability that are the cause of the trouble. The percentage of trees permanently affected or that die from this trouble are very small indeed. The greatest concern that this disease has caused the past year is that it is mistaken for the white pine blister rust. Almost invariably people believe this trouble to be the blister rust.

Pathologists have thus far never agreed just as to the cause of this malady. When it occurred in 1907 our pine owners were equally scared as to the future of white pine as at the present time, many going so far as to sell their pine stands at a sacrifice. The rainy season of the past year seemed to render conditions favorable for its development while in 1907 the season was dry; hence either extreme seems to favor it. It evidently is a physiological condition rather than a disease. The Massachusetts State Forester's report for 1907 gives quite a full report of this pine tree blight.

Conclusion.

There are numerous other more or less minor troubles affecting our forest trees, but I have covered the more important ones. From time to time undoubtedly there will come into prominence pests that heretofore have been relatively unimportant, but our main concern should be to perfect our forest practices and be prepared to cope with any and all forest troubles in a comprehensive and economic manner.

HONEY-BEES IN RELATION TO HORTICULTURE.

By Dr. Burton N. Gates, Amherst, Mass.

Delivered before the Society, with stereopticon illustrations, February 24, 1917.

Honey-bees in all ages have been of service to man; first as a source of food; later in his gradually acquired arts; and but recently subjugated to his scientific and technical needs. The keeping of bees is old; but the utilization of bees is older, in fact, older without doubt, than man's first utilization of the dog, the first domesticated animal. Hence, man's interest in bees and perhaps the keeping of them, is the oldest art under the sun. What is there more ancient unless it be man himself? Thus through a succession of ages are transmitted with increasing serviceableness, the inestimable honey-bee. To the ancients they were a source of food; more recently they were found to supply wax; but a half century ago commercial beekeeping came into being; and only today are we beginning to appreciate their greatest benefit, their invaluable service in the setting of our crops of seeds, fruit, and vegetables. Thus to the labors of the honey-bees, who work the world over, unnoticed and often unappreciated, may be credited millions and billions of dollars of service; yet to the unthinking mind a bee is merely a sharp sting, something to be avoided, shunned, or at the best, merely to gladden the taste with a drop of honey.

There are two kinds of bees, solitary and colonial (social). Solitary bees live isolated and singly, seldom becoming numerous. Among the colonial bees are the bumblebee and honey-bee. While the honey-bee may be classed as wild when colonies escape from apiaries, wild bees may be considered to include particularly all bees, solitary and colonial, other than the honey-bee.

When we speak of bees, the majority think of keeping bees for honey production, or sometimes one of the many other specialized

pursuits of the beekeeper. We might dwell upon this phase of the subject with due profit to the person who could undertake beekeeping, yet, even greater profits are in store for the person who can wisely use bees in his horticultural pursuits. Bees yield the beekeepers of the United States from twenty to twenty-five million dollars annually; but their profits to the seed grower, vegetable, fruit, and nut grower defy calculation. With unquestioned certainty, while usually well repaid for his labor and investment, the beekeeper secures only the minor income offered by bees. Honey-bees are of greater value to agriculture generally than to apiculture in particular; it is to their pollination services as pollen bearers, that mankind is indebted over and above their recognized value in honey and wax production. Honey-bees, therefore, should find unrestricted favor among all who grow seed, fruit, and vegetable crops.

Pollination.

The story of pollination, the act, its purpose, and result should be common knowledge to everyone. Pollination is affected differently in different flowers; its effects differ only accidentally. It is an act of sex, the enabling of offspring through the seed only being possible in most cases among higher plants, through a union of a male (pollen grain) and female (egg or ova) cell.[1] Some plants demand a cross in this act of pollination; others suffice with self or close pollination. Science and experimentation of late teach that cross-pollination results, in most of our fruits, in something better and even more salable, even in those apples for instance, which will set fruit with their own pollen and are self-fertile. These diversities and intricacies are apart from our present purpose and, in a measure, are in the field of botany, where voluminous information on the many phases of pollination are available. For us it is more a question of practical necessities and results than the operations of the plant machinery.

[1] What is believed to be the first announcement in recognition of sex in plants was made in 1682, by Nehemiah Grew, famous botanist, who explained that pollen must reach the stigma or summit of the pistil in order to insure a fruit. For the existence of the plant it thus became a question of cross pollination, in order to afford strength, vigor, and adaptability to its environment.

It will suffice to say that pollination is a recognized necessity; that among our economic plants the transferring agents of pollen are insects, and chief among these usually are honey-bees; that few, if any, of our important vine, bush or tree fruits, are wind pollinated; that cross-pollination is accepted as the rule rather than the exception; that cross-pollination results in better size, shape, quality (keeping and eating), color, firmness, flavor, texture and the like, as well as frequently in better production and prolificness.

It should be borne in mind, however, that the fruiting of the tree, as for instance, the apple tree, depends not only upon the insect pollination, but also on its cultural care. For instance, a crop of fruit will depend upon the vitality of the tree. In a year following a heavy crop, the pollen borne in the blossoms is less virile according to the statement made to the writer by Prof. J. W. Crow, of the Ontario Agricultural College. The same is true of diseased trees. "Microscopically," Professor Crow says, "the pollen can be detected as weak."

During this conversation Professor Crow alluded to other factors in pollination. "The best conditions," he says, "for the pollination of fruit trees, is just succeeding a shower." This has been determined experimentally. Moreover, the pollen supply is directly proportional to the set of fruit.

The act of pollination by honey-bees is usually in response to an effort to secure nectar or pollen for food. Hence the close relation of fruit and vegetable growing with beekeeping. Were it not for the flowers there would be no bees [1]; safely, too, it is assured without the bees there would be a shortage of fruits.

The Need of Honey-bees in the Setting of Crops.

It is recorded that in a Massachusetts town, some years ago, bees were banished by law, and as a result there was little fruit in

[1] It has been determined by evolutionary thinkers that flowers owe their form and color to insects, which have been the selective agency in blossom shape, and markings. Had there been no bees and similar insects, there would be no elaborate and many hued flowers; had there been no flowers, there would be no bees and similar insects, as we know them. There has been this dual biogenic interdependency for centuries, eras and ages, which today precludes separability of many plants and their insect pollinators.

that town, especially in its center. On the outskirts of the town fruits matured more plentifully, suggesting that the bees from the woods were able to work the suburbs but not the center of the community.

Today it could hardly be presumed that a community would banish honey-bees. It is becoming, too, generally recognized the important part which they play in securing our crops. Yet, to a large extent, the growers of crops are securing their insect and bee service without regard to controlling or reserving their services. They are still doing to a certain extent what the people of that early Massachusetts town did when they benefited from the services of bees of the woods beyond the limits of that town. Today many large orchards, market gardens, and seed growing areas, while they are having success, are without the producer's knowledge, depending on honey-bees which may be wild in the woods or located in adjacent apiaries. There is, however, considerable risk in this because seasons fail, climatic conditions are undependable, and more especially, the prevalence of insect and bee life in any given area may vary with these and from year to year.

It is a well-known fact that the prevalence of all wild life, be it plant or animal, is subject to fluctuations, due to favorable or unfavorable environmental conditions. In a given locality under favorable conditions, its numbers may rise or under unfavorable conditions, its prevalence may be less. Take, for example, a pest of mosquitoes or houseflies. In a given community these may be prevalent one year due to conditions favorable to their propagation, while unfavorable conditions will depress their prevalence during successive years. So with wild fowl and fish, weeds, and in fact all forms of life uncontrolled by man. This is in accordance with the unrefutable, biological law. Honey-bees and wild bees are in no way an exception. Even honey-bees under man's control are subject to these environmental effects. When favored their numbers rise to the crest of prosperity and prevalence. If unfavorable circumstances set in, for instance, the entrance of a bee disease, their numbers are reduced; hard winters may also depreciate them so that in the early season when their services may be most needed as pollen bearers their prevalence is at a low ebb.

Bees for the Horticulturist.

When the horticulturist or market gardener realizes that he is depending upon the services of the fluctuating wild bees or even colonies poorly maintained in his neighborhood, he asks what can be done to overcome this unreliability and assure himself that he is to receive maximum services when the pollination of his crops most need them. The answer and recommendation is an easy one. For the protection of his crops he has but to establish an apiary in proportion to the size of his orchard or garden, which will maintain a high frequency of honey-bees as pollinators and eliminate dependency upon wild honey-bees or honey-bees from neighboring apiaries, or more especially the services of wild insect life over which he may have no control and which may fail him at a crucial moment. There is little danger of over-pollinating the orchard or fields in insect life when pollination service is desired. It is far better to flood the orchard with bees during the blooming period than to have a scarcity. Furthermore, the cost of small apiaries for orchard and market garden purposes is infinitesimal as compared with the possible benefits and returns.

The common experience of orchardists during the fruit bloom period further intensifies the necessity for their control of the pollinating agencies. How common it is in May to have inclement weather conditions which do not favor the free flight of insects and particularly of honey-bees. While wild bees and wild insects are sometimes numerous in the vicinity of orchards in bloom, weather conditions may entirely prohibit their activities as pollen bearers or more particularly, should these insects, especially the honey-bees, need to fly a mile or more in order to reach the orchard, the pollination of that orchard may be entirely abandoned, due to the prohibition of the weather, hence, for certainty honey-bees should have easy access to an orchard. Numerous observations are on record wherein orchards were successfully fertilized when the honey-bees had less than one-fourth mile to fly, while more distant orchards bore no crops. Thus the apiary in or adjacent to an orchard will safeguard failure.

Particular results as observed by orchardists and beekeepers

are numerous and a limited number of those most significant and reliable are related elsewhere.

Among the climatic agencies which affect the orchard, it is generally agreed among fruit growers that prevalence of inclement weather, rain and the usually accompanying wind during the blooming period, causes the loss of more fruit than perhaps ill weather at any other season. The damage is manifold; pollen is washed from the anthers, stigma secretion washed away or diluted so that pollen may fail to germinate; chilled air reduces the vitality of the pollen, while an excess of moisture may swell and burst the grains.

There is an accompanying factor which may serve to counteract, in part at least, unfortunate weather conditions. The Kansas Agricultural Experiment Station is responsible for the statement "that an insufficient supply of bees will hinder the setting of fruit and while other insects may take part in carrying the pollen, the fruit raisers must rely chiefly on honey-bees." Apropos of this delayed bloom, in "Bienen-Varter" are given the results of experiments in which netting was put over the branches of trees at the time of their blooming. On the covered limbs the blossoming period was prolonged as if the flowers were waiting for the bees to pollinate them. The time of prolongation of the bloom on these covered limbs in comparison with uncovered blossoms, is as follows:

Apple trees, 1 to 3 days,
Pear trees, 4 to 5 days,
Plum trees, 4 to 7 days.

Incidentally it was reported that the fruit failed to set on the covered branches.

A notable example of the effect of unfavorable climatic conditions during the blooming period of the apple orchard is reported by F. A. Merritt of Andrew, Iowa; "Our apple orchard is situated in such a way that it is exposed to both the north and south winds. About four years ago when the trees on the south row (Transcendents, they throw out a heavy growth of foliage at the same time it blooms) began to open their bloom, a heavy wind prevailed for about five days. I noticed during this period that the bees could not touch the bloom on the south side of the trees, but worked merrily on the more sheltered limbs of the north side. What was the result?

Those limbs on the north side were well loaded with fruit while on the south side there were almost none to be seen."

Fruits and Vegetables Pollinated by Bees.

Among the many cultivated plants in northern latitudes which are pollinated by honey-bees are the apple, pear, plum, quince, cherry, peach (to some extent), mulberry, peas, beans, currants, grapes, squashes, melons, cucumbers, and the cranberry. In the beekeeping literature, as well as in the publications of horticulturists, are many instances of the value of bees in setting these various fruits and vegetables. It will only be possible to select significant illustrations.

The Apple. It was reported to the writer in 1916, as observed by a fruit grower, that merely the top branches of his apple trees bore, while the lower ones, which had bloomed equally well, did not fruit. The only possible explanation which has been arrived at is that the top branches were in the path of bees which pollinated the top bloom but failed to reach the lower.

Perhaps the most significant report of the effect of the introduction of honey-bees to the apple orchard is this specific instance of a practical orchardist, Mr. Ralph C. Waring, of Colville, Wash. Two orchards of about equal acreage in a western "pocket" in the foothills of an admirable fruit land, well drained and protected from frost, were owned respectively by two men. One grower secured large crops, while his neighbor secured none, although his fruit trees were of the same age and blossomed heavily each spring. The owner, in despair of financial ruin, called upon the State Experiment Station for assistance. A specialist, who was a pomologist and entomologist, investigated the two entirely comparable orchards, and was about to leave without solving the problem when the question of bees arose. Upon inquiry it was asserted that no bees had been maintained for either orchard. Again going over the ground more carefully, the specialist found in a neglected corner of the fruiting orchard, a fallen log partially sunken in the damp land. This sheltered a very large colony of bees; to its services is attributed the success of the orchard. The following

year bees were provided in the orchard which had previously failed to fruit, resulting in a crop on which the owner netted $3,000.

Pears. The authority which is usually quoted for the pollination of pears is Norman B. Waite, in his publication of the United States Department of Agriculture, entitled "The Pollination of Pear Flowers." He says, "The common honey-bee is the most regular important and abundant visitor and probably does more good than any other species." According to Professor Waite, moreover, "pears require cross pollination, being partially or wholly incapable of setting fruit when limited to their own pollen. Some varieties are capable of self-fertilization. Varieties that are absolutely self-sterile may be perfectly cross-fertile." These are but a few of the thirteen or more conclusions which are drawn regarding the cross-pollination of pears. A thirteen per cent set of pear bloom is considered an average fruit catch, while a five to six per cent catch gives a heavy apple crop (ten to fifteen per cent is rare).

Plums and Prunes. A. H. Hendrickson [1] has been investigating prune and plum pollination during the past several years. Observation in 1915 was made of 50,000 plum and prune blossoms, and in 1916, 87,000. These observations have enabled him to draw the conclusion "that all varieties of the Japanese group of plums (*Prunus triflora*) are self-sterile with the possible exception of Climax. Varieties of this group seem to cross-pollinate readily. Of the European varieties of plums (*Prunus domestica*) Tragedy and Clyman show distinct evidence of self-sterility."

Of the prune, the French and Sugar prunes seem to be self-sterile to some extent. Robe de Sergeant and Imperial prunes are distinctly self-sterile. They, however, seem to cross-pollinate satisfactorily.

These observations were the result of a noticeable lack in the setting of certain orchards. The normal set of French prunes was about 4% as compared with 19% which was covered with a mosquito net tent under which bees were confined. Thus it has been concluded that the "French prune at least may be aided in setting a satisfactory crop by the presence of a large number of bees in the

[1] University of California Bulletin, 274, "The Common Honey-bee as an Agent in Prune Pollination."

orchard during the blossoming period." Further, "Without the aid of bees or other insects, the set of fruit on the French prune is often light." Moreover, "the Imperial does not seem able to set fruit unless pollinated by insects with pollen from the trees."

As a result of these observations, the author has stated that some growers will maintain their own apiaries, others will hire bees, while still others will give apiary rights in their orchards. The investigations and experiments are to be continued.[1]

Cherry. Observations were also made on cherries during 1916, showing that the "leading commercial varieties grow in the State [of California] including Napoleon (Royal Ann), Lambert, Bing, Black Tartarian, and Black Republican are self-sterile. There is also distinct evidence of intersterility between several varieties, for example, Bing and Napoleon. The work has not yet gone far enough to determine the best pollinizers for cherries in this State."

It has also been reported elsewhere that the owner of a large cherry orchard in California did not harvest any crop for eight successive years. In desperation he was about to dig up his trees when he was advised to introduce bees, with the result that he afterwards sold his cherry crop in the Chicago and New York City markets for $4,000. It is also reported by another Californian that one hundred colonies are necessary for one hundred and forty acres of cherry trees.

For Massachusetts conditions, everyone who has any familiarity with the pollination of cherry trees, recognizes at once the tremendous activities which bees make in our cherry trees while in bloom. The writer on one occasion observed that only that portion of a cherry tree which was sheltered from the west winds by a house, was satisfactorily pollinated and set fruit. There can be little doubt of the importance of honey-bees in cherry pollination.

Peach. Professor J. W. Crow, of the Ontario Agricultural College, in remarks made in January, 1913, says "that some varieties of peaches are as dependent on bees as are apples." The writer's observation, however, is that bees are less active in blooming peach orchards than they are in many other fruit orchards. This may not be due to the lack of nectar in the peach bloom, but

[1] Journal of Heredity, Volume VII, December, 1916, page 545.

perhaps to an excess of nectar elsewhere, which fact would only emphasize the necessity for additional bees if their service is expected in setting peaches.

In the orchard house of Stephen Morris, Philadelphia, where peaches are grown by the bushel in fifteen-inch pots under glass, the grower attributes much of his success to the effectual pollination of the blossoms by bees. It is his custom to place a colony in the house as soon as the buds appear. The bees remain until the petals fall.

Raspberry. It is only necessary to ask any good beekeeper in a raspberry growing district whether the bees visit raspberry bloom; he will tell you that some of the finest honey on the market is raspberry honey. All forms of raspberry, wild and cultivated, are most frequently attended by honey-bees.

Blackberry. While there is this peculiar affinity of the raspberry for bees, the blackberry, at least certain species, are less frequently visited. Some forms of wild blackberry are visited by bees more readily than apparently are cultivated varieties.

Strawberry. There seems to be a considerable diversity of opinion in regard to the importance of bees in strawberry culture. Professor J. W. Crow of the Ontario Agricultural College, in January, 1913, said "Strawberries are five to ten per cent wind pollinated. A strawberry as soon as pollinated drops its petals, otherwise it remains for a longer time receptive to pollen." In 1916 Mr. E. G. Carr of New Jersey assured the writer that "bees worked strawberry beds freely in New Jersey." The writer has also seen bees active on strawberry plots in Maryland. These same plots at certain times and under given circumstances, apparently are unvisited by honey-bees. There is doubtless a chance for further observation along the line of the effect of climatic conditions perhaps on the nectar flow on strawberries. There is always to be regarded, too, the counter attraction of other nectar sources when strawberries are in bloom.

Cranberry. Recent investigations have shown that honey-bees are of prime importance in setting cranberries. The owners of cranberry bogs in Massachusetts, realizing this, are maintaining their own apiaries, or hiring colonies for service on their bogs. It is estimated that it is desirable to have one colony for every two

acres. The results of experiments with bees in cranberry culture have been reported by Dr. H. J. Franklin, of the Massachusetts Agricultural College Experimental Bog in Wareham. It is not maintained, however, that the honey-bee is the only bee of service in the cranberry bog, for the solitary bees are also found.

Almonds. During 1916[1] "Observations on almonds by Tufts show that there is a distinct pollination problem with this fruit. Thirteen varieties, including practically all grown on a commercial scale in California, proved to be wholly self-sterile under conditions existing at the University Farm. . . . Of still greater importance is the fact that two leading varieties were found to be intersterile as well as self-sterile."

It is well known to beekeepers that bees work almond trees. Some of the large and successful apiaries of California are located in almond orchards.

Vegetables. Chief among the vegetables which depend upon the honey-bee to a considerable extent for pollination are all the cucurbitaceous varieties, as field squash, cucumbers, melons, pumpkins, and the like. An observation has been made by Mr. Gregory of Massachusetts, who asserts that honey-bees are highly important in the setting of squashes, and claims also that the honey from squash is inferior.

It has been repeatedly observed that honey-bees are utilized in field cucumber growing, especially where a large number of small pickling cucumbers are produced. In Massachusetts, too, one noted melon grower hires bees for the sole purpose of setting his melon crop. This producer has told the writer that to his utilization of bees he attributes in a large measure his success with muskmelons and cantaloupes, which he sends to the finest hotels in the country.

The growing of cucumbers under glass, while a special industry, is merely the adaptation of the utilization of honey-bees. Annually several thousand colonies, perhaps three thousand, are used in the cucumber greenhouses in Massachusetts alone. Hand pollination is impossible and long ago dispensed with. One grower alone uses upwards of eighty colonies a year.

[1] Journal of Heredity, Vol. VII, No. 12, December, 1916, "Pollination Studies on California Fruits," page 545.

Bees to some extent have also been used in the setting of tomatoes in greenhouses, and by some it has been thought that a better crop of tomatoes is secured thereby.

Securing and Maintaining Bees.

Honey-bees are available for horticultural purposes in several ways. In some instances, a small number of colonies are hired for a period of a few weeks during the blossoming time of some particular crop. In other instances, fruit growers induce beekeepers to establish an apiary in their orchard, by granting them privileges and accommodations. For instance, in California, orchardists not infrequently furnish sites for apiaries and offer other inducements to locate there, as perhaps the orchardist will furnish the stands for the bee hives. This is typical of the coöperation of fruit growers and beekeepers throughout the Sacramento Valley. In Wisconsin, too, it has been stated that all large orchardists now have their apiaries in or near by. Many of the more thoughtful growers, however, believe it advisable to maintain their own bees. This can be done in one of several ways; given the time and the aptitude, the orchardist or some one hired for the purpose, may be the beekeeper; otherwise a circuit beekeeper may be employed. This practice is growing in favor among those owning moderate sized orchards, as well among the greenhouse cucumber growers and cranberry growers. The custom is to hire a practical apiarist to come periodically and care for the bees. Thus if this practical apiarist has similar engagements throughout a given district, the expense to each orchardist or cranberry grower is slight. Moreover, this coöperative plan assures the maximum efficiency of his colonies without burdening him with additional detail.

In securing bees for horticultural purposes one of the first requisites is healthy stock. Those who maintain bees for greenhouse purposes, will find it advantageous to own their own colonies rather than to purchase annually.

Purchasing the Stock. If bees are purchased it is advisable to secure healthy stock. Bees are subject to at least two prevalent diseases, known respectively as American foulbrood and European

foulbrood, to which colonies unattended may succumb rapidly. The inexperienced, therefore, should secure information and ascertain that the bees have been inspected for disease. Should disease set in a considerable loss of both bees and possibly to the orchard or market garden might result in a short time. Information concerning these diseases may usually be had through experiment stations, agricultural colleges, the U. S. Department of Agriculture, or in many states, through the Inspector of Apiaries.

Usually it is desirable to secure bees in hives which have removable frames. The ten-frame Langstroth hive is considered standard. By such an equipment uniformity with stock acquired later on or supplies procured is more readily assured. The bee for general purposes is the Italian bee.

Since the subject of this paper precludes an exhaustive discussion of the manipulation of bees, details concerning this may be had upon request of the author. There are, however, numerous books, bulletins and other sources of information available through the public libraries.

Alleged Injury to Fruit by Honey-bees.

It is occasionally alleged that bees damage the orchard in one of several ways. In one instance the writer was complained to by a farmer that the bees from his neighbor were "sucking the sweetness out of the flowers. They are there in thousands and are making the petals drop. I will be ruined by fall if something is not done." How little he realized, however, the good services which the bees were performing.

Sometimes it is concluded too hastily when bees are seen upon fallen and partially decayed fruit or possibly on overripe peaches which are still on the tree, that the bees have cut holes in this fruit. It is thought that the honey-bee is the cause of the injury. On the other hand, if the honey-bee's activity could have been traced, it would have been found that something other than the bee had first pierced the skin of the fruit. Investigations show that wasps or birds do this or that a fungus may disintegrate the skin. In some such break in the skin the honey-bee can work, but not until

the skin has been broken by some other means than that which the honey-bee possesses can she gain access to juices, even to so tender skinned fruit as grapes or plums. It has been proven by experiments that the honey-bee is physically incapable of puncturing a sound fruit.

In some instances redress for alleged damage to ripe fruit by honey-bees has been referred to the courts. One of the most celebrated cases of this kind was that of Utter *vs.* Utter, having taken place at Amity, N. Y. This case resulted in the unanimous decision of the jury to the effect that bees do not puncture sound fruit.

Experimental tests of the ability of bees to puncture fruit have been made at the Ottawa Experiment Station in Ontario, Canada. Ripe strawberries were first tried and then raspberries. These were suspended within the hives as well as in other places of easy access to bees. The fruits were exposed in at least three different ways. First, the whole fruit; second, whole fruit which had been dipped in honey; and third, similar fruit but with a slight pinhole puncture in each. A second series of experiments was made similarly with peaches, pears, plums, and grapes. "The bees began to work at once both upon the dipped and punctured fruit. The former was cleaned thoroughly of honey during the first night; upon the punctured fruit the bees clustered thickly, sucking the juice through the punctures as long as they could obtain any liquid. At the end of six days all the fruit was carefully examined. The sound fruit was still uninjured in any way. The dipped fruit was in like condition, quite sound, but every vestige of honey had disappeared. The punctured fruit was badly mutilated and worthless; beneath each puncture was a cavity, and in many instances decay had set in. The experiment was continued during the following week, the undipped fruit being left in the brood-chamber; the dipped fruit was given a new coating of honey and replaced in the super, and a fresh supply of punctured fruit was substituted for that which had been destroyed.

"After the third week the bees that belonged to the two hives, which had been deprived of all their honey, appeared to be very sluggish, and there were many dead bees about the hives; the weather being damp and cool was very much against those colonies. These colonies had lived for the first three weeks on the punctured fruit and on the honey off of the fruit which had been dipped;

as there were at that season few plants in flower from which they could gather nectar, these bees had died of starvation, notwithstanding the proximity of the ripe juicy fruit. The supply of food which they were so urgently in need of was only separated from them by the skin of the fruit, which, however, this evidence proves, they could not puncture, as they did not do so."

Alleged Injury to Pear Orchards by Blight.

Some years ago, opinion among fruit growers that bees were agents for transporting the spores of pear blight and thus the agent of dissemination of this dread plant disease, became prevalent. Various experiments were carried on in order to prove the assertion. In 1901 considerable trouble arose in Kings County, California, between the pear growers and beekeepers. The situation became tense. Further investigations were made. Bees were temporarily removed from pear orchards, but this precaution was found not to prevent the spread of pear blight. It was therefore assumed that there were sufficient bees, wild honey-bees and other insects, including ants, which were going from tree to tree by thousands, and hence were also agents in the transportation of pear blight. These were conditions over which man had no control. Hence, the honey-bees were allowed to be returned, it having been concluded that these should render invaluable service in the cross-pollination of the bloom. Recently investigations, notably those of Dr. J. H. Merrill, have fortunately for the beekeeper's interest, vindicated the honey-bee. In fact, it is improbable that the honey-bee has any part in fire-blight dissemination. By inoculation experiments and extended observation, aphids or plant lice which infest fruit trees, are found to be an active means of transmission. In conclusion of his latest observations, Dr. Merrill says,[1]

"1. The blight developed only in the tender succulent growth on the twigs.

"2. By hatching from eggs laid in blight cankers, the aphids come in contact with the fire-blight organism.

[1] Dr. J. H. Merrill, 1917, "Further Data on the Relation Between Aphids and Fire Blight (*Bacillus amylovorus* Bur. Trev.) Journal of Economic Entomology, Vol. 10, No. 1, pages 45–46.

"3. Aphids can and do inoculate trees with the bacteria of fire-blight.

"4. The amount of fire-blight infection in an orchard may be materially decreased by destroying all of the aphids which may appear there."

Injury to Cultivated Flowers.

Occasionally a beekeeper says that bees are injuring cultivated flowers, grown perhaps professionally by the floriculturists. The bees can hardly with justice be blamed. They are responding merely to their natural inclinations, namely to secure pollen or nectar. Having visited a flower and perhaps pollinated it, the flower at once responds according to its natural inclination, with the results that it drops its petals. In this way bees may cause flowers to pass more quickly than might be desired. It is pursuant to the law which was observed in the prolonged blooming period of apple orchards due to lack of pollination and which is mentioned above. If flowers are grown under glass and bees tend to mature them too rapidly, the floriculturist may exclude the bees by screening his greenhouse windows. Snapdragons are an example of a flower which quickly responds to pollination and drops its lower blooms, thus giving a ragged or unsightly stalk. A floriculturist on one occasion called the writer's attention to a considerable quantity of snapdragon which had been injured, from the market standpoint, by having been visited and pollinated by bees. However, on the whole this type of injury by bees can hardly be credited as being usual or severe.

Spraying *vs.* Beekeeping.

Of late there has been considerable discussion among the fruit growers and others who practice spraying and the beekeepers. Beekeepers have claimed severe losses due to injudicious and improper spraying. It is a pleasure to say the beekeepers are not narrow enough to presume that spraying should be stopped and yet, there is justification for their presumption that spraying should be done properly and in such a way as not to injure or destroy their

bees. On the whole good spraying practices will in no way conflict with the beekeeper's interests. Occasionally there may be some slight damage, but wholesale destruction has usually been traced to improper spraying practices. Generally speaking, it will suffice to say that a tree, or bloom of any kind, does not need to be sprayed until the petals have fallen. At this time bees are not inclined to visit the flowers, hence there can be little danger of injuring the apiary. The problem as a whole, however, is an intricate one, and where questions arise as to the time and advisability of spraying, they should be referred to an authority for discussion or settlement.

Experiments have been and are being made on the use of repellents to bees in spray mixtures. Beekeepers hope, and doubtless fruit growers and those who use spray poisons will be glad to coöperate, that the time is not far distant when the bees can be repelled so that by no accident will they come in contact with a poisonous spray. As yet, no definite instructions can be given for the use of repellents to bees in spray mixtures.

As a preliminary observation, the writer[1] on July 7, 1916, applied lime-sulphur spray to a European linden which was in full bloom. One-half only of the tree was sprayed with a solution of 1–25, the strength usually employed in spraying operations. The spraying was done between 9: 30 and 10 o'clock in the morning of a bright calm day. The following observations were obtained:

Results of Lime Sulphur as a Repellent.

In the sprayed half of the tree: —
15 honey-bees.
Some wild bees.
1 milkweed butterfly.
Flies of various types numerous.
In the unsprayed half of the tree: —
53 honey-bees.
Wild bees.
Flies numerous.
4 Bombus.

[1] Gates, Burton N., Seventh Annual Report of the State Inspector of Apiaries for the Year 1916, Mass. State Board of Agriculture, Apiary Series Bulletin No. 11, pp. 16–19.

Apparently, however, after the first day, there was an increased number of bees in the sprayed portion of the tree, and a decrease in numbers in the unsprayed portion, which suggests the loss of repellent powers in the sprayed portion and a decrease in the general activity of the bees working linden; hence the observations may be questioned. On the third or fourth day, scarcely a bee could be seen in any part of the tree. Thus with limited trials, no definite conclusions could be reached.

A report of Forest Commissioner Wm. W. Colton, of Newton, along these lines, is that a material similar to sulpho-naphthol, "Milkol" may serve as a repellent. His observation is the result of having used "Milkol" in municipal spraying, during the season of 1916.

Summary.

Bees and beekeeping are inestimably important to the horticulturist. He may fertilize and cultivate the soil, prune, thin, and spray his trees, in a word, he may do all those things which modern practice advocates, yet without his pollinating agents, chief among which are the honey-bees, to transfer the pollen from the stamen to the pistil of the bloom, his crops may fail. Honey-bees in an orchard are an item of assurance or insurance and protection. Usually the expenditure is so slight that it does not warrant comparison with the possible and probable returns.

STRAWBERRY CULTURE.

By O. M. Taylor, Geneva, N. Y.

Delivered before the Society, March 3, 1917.

Of all the small fruits which occupy the time and attention of both New York and Massachusetts growers, the strawberry is outrivalled by neither blackberries, raspberries, currants, nor gooseberries, its acreage for Massachusetts more than doubling the combined area of all these fruits, according to the figures of the last Government census. This position of deserved popularity is held not through any manipulation of real estate brokers or of stock markets or from glowing descriptions of printer's ink and artist's brush, but because the fruit has won its high standing on its own merits.

It is true that the strawberry is the first of the small fruits to tempt the eye and the appetite in early summer and doubtless this fact adds to the zest with which the fruit is greeted at that time; but few indeed are the people who are not delighted both outwardly and inwardly by the handsome appearance, delicate aroma, and pleasing flavor of this class of fruit. Home-grown fruits begin to ripen about the middle of June or slightly earlier and for about three weeks there is no time when the table should not be supplied in abundance with the choicest berries and if one chooses to gather fruit in July, August, September, and October, and occasionally in November, it may be done by giving attention to some of the fall-bearing kinds; and we are then in position to echo the statement of Bryant as to the

> "Fruits that shall swell in sunny June
> And redden in the August noon."

A discussion of the culture of the strawberry leads into too many paths and byways to make it at all possible for a full consideration of the subject at this time, and in the attempt to touch upon some of the most important factors of its successful culture it will be necessary to ignore completely many points and to touch others

very lightly, while more attention must be given to some of those subjects which are the determinants of success or failure, any one of which, if lacking, may spell disaster to the strawberry grower.

It is taken for granted that the greatest interest centers around the growing of the strawberry for commercial purposes and not for home use although the latter field is far too much neglected, the requirements of which are somewhat different from the commercial end of the business. For instance, in the home the question of quality stands first, and heavy yield is not so essential, but for commercial work, no matter what happens, the variety must be sufficiently firm to ship well and the plants must be good yielders.

Detailed statements of actual operations are not in order at this time. They vary with the locality and the particular environment, and are as diverse as are the number of men growing the fruit. But there are certain essential factors of strawberry growing which are unchangeable wherever strawberries are grown and which will apply in Massachusetts just as they equally apply in New York or any other state. Any variety of strawberry to do well must be adapted to its environment and must find its local surroundings congenial or it will fail in part or altogether and become a profitless instead of a profitable kind.

Soil and climate with its twin subjects of temperature and rainfall spell success or failure with the strawberry. Fortunately, temperature feels more kindly disposed toward the strawberry than is the case with the raspberry and blackberry and it is seldom we hear of winter injury to this fruit, especially if the ground has its normal covering of winter's snow and if the plants have had their blanket of some mulch material. The fruit itself is occasionally injured by the intense heat of the sun, especially during showery weather, but the plants as a whole may be considered hardy.

Rainfall, however, is a more trying problem. The strawberry, of all small fruits has its root system nearest the surface, has the smallest capacity of soil space for root run and consequently is more quickly affected by varying conditions of moisture. This is especially true at fruiting time, during which a few days of severe drought may reduce the yield fifty per cent. There must be present, therefore, if the strawberry is to succeed, a proper amount of moisture whether it is supplied naturally or artificially.

The soil is the next important determinant. There is no question but that many varieties are partial as to soils. Just what the determining soil character is, cannot always be ascertained. We know that some varieties prefer a heavy clay soil, while other kinds are only at home in a light soil type, and doubtless many a variety would become surprisingly profitable could its soil preference be known. In a general way, however, most varieties are at their best in a wide range of soils, with the preference toward a well-drained, loamy soil, not too heavy, containing an abundance of available plant food and humus. Levels or slopes and direction of exposure are usually of minor importance.

Climate and soil being well disposed, there yet remain several factors of location which at once become great assets or heavy handicaps. These are distance of market, road conditions, character of market, facilities having to do with transportation, whether by rail or water, the availability of plenty of cheap and reasonably efficient labor. The ideal market is a good local one, but at the same time with opportunity to shift quickly to a more distant market whenever desirable and it is also a great asset not to have that market under the control of distant growers who through more favorable conditions are able to capture and often flood it just as the local fruit reaches maturity.

There is great agreement as to the value of stable manure for the strawberry. Discord and harsh sounds greet the ear, however, when an attempt is made to line up the best fertilizers for this fruit. No sooner has one grower solved the problem to his personal satisfaction than his neighbor goes him one better by securing a much heavier yield and a more handsome product with a formula quite different. Another grower trys to copy the method of his successful neighbor only to meet with failure. Growers should experiment by using various amounts and kinds of the fertilizers rich in the chief elements of plant food, nitrogen, potassium, and phosphoric acid, until by trial they have worked out the preparations which give them the best results under their own farm and soil conditions.

A discussion of varieties and how to select them is reserved for a later paragraph. Some attention, however, should be given to the kind of plants to set. Are all equally good? Can we secure an advantage at the start by good judgment in the selection of the

stock for the new plantations? From where and what plants shall we select? Shall we turn to the much advertised "Pedigreed" or "Improved Strains" or can we by selection build up a class of plants superior to the ordinary run? Time forbids a detailed discussion of these questions. Briefly stated, strong, vigorous, stocky, apparently healthy plants, with a good root system will start into new growth more quickly than weaklings, and stock should be taken from vigorous beds which have not become exhausted by a yield of fruit, selecting the larger, more mature, and older runner plants in preference to those developing late in the season, found along the outer border of the strawberry row. Experience has already taught growers to look with suspicion at the well-written, glowing accounts of the great value of "Pedigreed" stock or "Improved Strains" which are usually quoted at a high price. Many times such plants are no better than those close at hand of the type just described as a desirable stock. Would that we were certain by careful, continued selection to build up improved strains. Apparently a correct and plausible theory, and one which naturally commends itself to all who are desirous of raising the standard of excellence, yet no indisputable proof has been brought forward that such is the general result, while strange to say some of the most painstaking and careful experiments carried on continuously for a dozen years or more have left the experimenter in the dark as to the correctness of this whole theory and this statement holds true with tree fruits as well as with the strawberry. All efforts, however, to improve the plants should be encouraged, for the best are none too good.

Sex of Varieties. Some attention must be given to sex. The grower should know whether his varieties are perfect or imperfect, flowering or staminate or pistillate as they are sometimes called. The present tendency is toward the perfect-flowering kinds although some excellent varieties like the Sample and the Columbia are among the imperfect-flowering kinds, and where such kinds are grown provision must be made through the selection of other varieties to provide for the cross pollination of the blossoms. The fertilization of all strawberry blossoms is made possible mostly through the work of insects as they journey from flower to flower. As a rule more efficient pollination may be expected if more than

one variety is grown in the same field, and there is no danger of any change in color, shape, or flavor through the influence of the pollen of different varieties. Weather conditions, rains, cold, heavy winds, frosts, lack of insects, or the particular variety, all have a bearing on the completeness or incompleteness of the fertilization of the blossoms and upon the increase or decrease of "nubbins." Contrary to the opinion of some growers, there is no correllation between sex and yield.

Preparation of soil. "Well begun is half done" in preparing the soil to receive the strawberry plants and seldom if ever is its preparation overdone. If the soil be foul it may be necessary to begin a year before setting the plants by the use of cultivated crops. The applications of manure to the soil, time and depth of plowing, particular methods of bringing the soil bed into the best possible condition for the plants are as diverse and various as are the men growing the crop. There is no one method best adapted to all conditions and soils. Emphasis, however, should be laid on the importance of a well-prepared, thoroughly worked soil which has been put into good tilth, so that the plants will "take hold" as quickly as possible after setting.

Preparation of plants for setting. No elaborate system of preparation is necessary. The plants should of course not be permitted to wilt and dry out during the interval between digging and planting; dead runners should be removed, as well as some of the older leaves and the roots "shortened in" about one-third their length.

Setting the plants. There is no uniformity among growers as to distance between rows and plants, the exact time or method of setting, or the system used. Plants should not be crowded. Distance depends partly on the habit of the variety and partly on the system of growing, whether it be the matted row, the hill, or a modified form of either. The matted row system which is in most common use calls for a width of about four feet between rows, and from eighteen to twenty-four inches between plants, while the hill system requires less space each way. Both methods have their advantages and disadvantages. All are agreed as to the desirability of setting at the proper depth, neither too shallow nor too deep, the crown of the plant being on a level with the surface of the ground, and in New York spring setting is the rule.

Treatment the first summer. Cultivation should begin as soon as the plants are set, and should be repeated whenever necessary to maintain a good physical soil condition about the young plants, and is dependent largely on type of soil and condition of rainfall. Usually the entire land is given over to the strawberry crop but under favorable conditions inter-crops or companion crops of low and quick growing vegetables are used but this is not a common practice. Spring set plants should not bear fruit the first year, the blossom clusters being removed, so that the plants themselves may develop more rapidly. The first runners should be encouraged to root as soon as ready. The cultivator must be narrowed as the runners occupy the ground. It is doubtful if the practice of sowing a cover-crop among the plants in the fall should be encouraged, as the disadvantages more than offset the advantages gained.

Winter treatment. Strawberry plants are perfectly hardy yet some winter protection should be provided. The frozen ground should be covered lightly with some material of a strawy nature, not for the purpose of keeping the plants warm but to lessen the damage to the plants from the repeated freezing and thawing of the ground. This is but one of a half dozen benefits to be secured by the use of a winter mulch. Materials used are dependent on what may be available, anything that will accomplish the results desired, and which will in no way injure the plants.

Treatment the fruiting season. The strawberry bed usually requires but little attention the following spring. As warm weather approaches the winter mulch may require stirring to keep the plants from becoming smothered and when too thick the surplus is placed between the rows. Occasionally if land is foul it may be necessary to remove the mulch and cultivate between the rows after which the mulch is replaced, and the largest weeds cut out or pulled after rains. It is doubtful if the possible benefit of smudging as a protection against late frosts at blossoming time will warrant much expense in the purchase of any of the various smudging devices now on the market. The certainty of any benefit is far too uncertain.

Renewal of beds. Generally but one crop of fruit, yet in many cases two and occasionally three crops are removed before the strawberry bed is discarded. It depends largely on the condition

of the bed. No ironclad rule can be laid down, either as to how many crops shall be harvested or the particular method to follow in the renovation of the old bed. Usually by some method the matted row is narrowed down, the ground which has become hard and compact by the pickers is broken up and thoroughly worked, the remaining plants put in the very best possible condition to start new growth, stable manure or fertilizer added if available. There is no uniform practice as to mowing and burning over the old bed, some successful growers never omitting the operation, while other equally as successful growers never practice the method. It has some advantages and also some disadvantages.

Irrigation of strawberries. The importance of an adequate supply of moisture has already been referred to. All strawberry growers are familiar with the disastrous effects of periods of drought and it would seem at first sight as highly desirable to install some system whereby one would not be at the mercy of the elements as far as they relate to the water supply. Were it possible to control or regulate natural rainfall or to prognosticate the future weather conditions with accuracy, a regular, never failing, always available artificial water supply might become a valuable asset to the strawberry grower, but unfortunately, in New York State at least, we not only have no control over nature's operations but also are exceedingly poor guessers when it comes to foretelling the weather; and the experience of many a grower who has installed some plant, as the "Skinner" system for instance, has found that the systems rust out far quicker than they wear out and that in a series of years there has been but little if any financial return at all adequate to the amount of investment involved. There are, of course, exceptions to this experience. It would seem, however, judging by past experience, to be highly desirable to more fully make use of the means already at hand of conserving and utilizing the moisture supply normally available through more intensive methods of cultivation, and of previous soil preparation, especially by increasing its capacity to hold and retain moisture.

Pests and their control. Some benign influence must brood over the strawberry, shielding and protecting against many of the troubles that fruits are heir to, for it may truthfully be said that items for spray machinery and for spray materials are conspicuous

by their absence from the expense account of the strawberry grower. But very few if any strawberry growers ever spray. This does not mean that this fruit is immune from attacks of insects or fungi, but it emphasizes the truth of the statement just made as to comparative freedom from such troubles. The rotation is so short — the shortest of all the small fruits — that the pests are scarcely able to obtain a foothold. White grubs are occasionally troublesome, being the larvae from the "June bugs," and are most abundant in grass lands, which should be avoided as far as possible, although fall plowing may destroy some of the insects. Leaf rollers are sometimes in evidence, small, brownish caterpillars which roll or fold over a portion of the leaf, feeding within the protecting fold. Arsenate of lead, applied before the insect is protected or burning the beds after fruiting and if necessary, a later arsenical spray will destroy many of the insects in cases of severe infestations. The strawberry weevil occasionally puts in an appearance. Unfortunately, the egg which hatches into a whitish grub is laid in the flower bud where the grub feeds on the pollen. No satisfactory remedy can be given. Burning over the beds, clean culture, and a quick rotation furnish some relief.

Among diseases, leaf spot is the most serious trouble, but is dependent on certain weather conditions. Good air and soil-drainage with selection of somewhat resistant varieties aid in reducing the amount of injury. In severe cases, spraying with bordeaux mixture (3–3–50) as growth begins and again just before blossoming time will be found beneficial. Arsenate of lead may be combined for insect troubles. A quick rotation already referred to, tends to keep down both insects and disease.

Picking and marketing. Well begun is half done; yet the strawberry grower is scarcely more than half done when the fruit reaches maturity. There yet remains the task of picking, packing, shipping, and marketing the fruit, during which time the grower is largely at the mercy of weather conditions entirely beyond control. Here again, details vary to suit the locality or the whim or notion of the grower and are almost as various as the number of growers; but all are agreed on the importance of having the fruit arrive at its destination in good condition, free from bruises, well colored, fairly uniform in size of berry, packed neatly in clean, attractive-

looking baskets. The acme of success can never be reached when berries of all sizes and colors, with and without hulls, overripe and underripe are placed in the same box.

Yields, costs, and profits. Would that it were possible to make accurate statements in regard to productiveness, the many items of expense connected with growing the crop and in addition to these, all the items comected with harvesting and marketing the crop, including the all-important item of selling price, so that profits, always alluring yet by far too elusive, might be determined, or as sometimes occurs, the amount of loss determined. Were all factors constant, the results would be a question of mathematics, but unfortunately some items vary from year to year, others are never alike on any two farms, while still other factors are entirely beyond the control of the grower, making hasty determinations of probable yields, costs, and profits largely guesses and at this time we leave all such calculations to others.

We are, however, concerned with averages, which will appear low to many of the more successful growers, but they represent the concensus of opinion among conservative observers. 3000 quarts per acre is considered an average yield, while the average cost of growing a 32-quart crate of berries and placing it on the market is in the neighborhood of $1.00 per crate, placing a fair profit at about $1.00 per crate, the amount of yield largely determining the amount of the profit.

What to plant. We come now to our last subject, by no means least in importance, always one of the most perplexing and baffling of solution. With the best of climatic and soil conditions present, with clear-cut ideas as to the best cultural methods to follow, and with the knowledge that the best of markets is at our door, the selection of undesirable varieties may from the very start spell ultimate disaster and make all the difference between a profitable or a profitless business. Were there but few varieties available for selection and were the behavior of these varieties uniformly the same in different localities, and under various environments and in different soil types, this question would be simplified; but the fact is altogether too apparent that varieties are amazingly unstable in their behavior and the most profitable variety in one location may prove worthless or of only mediocre value elsewhere.

Of all the small fruits, the strawberry lends itself most readily to the rapid increase of varieties and catalogs are overburdened with long lists of kinds described and often illustrated in such glowing words and colors that the novice in despair would fain swallow the whole list, did space permit. The multiplicity of varieties is apparent on every hand. Fletcher, in his recent work on "North American Varieties of Strawberries" lists nearly 1900 variety names and some of our largest small-fruit nurserymen in their 1916 catalogs offer to supply growers with their choice from over 80 different kinds.

Manifestly, it is impossible for growers to test all varieties claiming attention. What then, are the guideposts to indicate the route to travel in making an intelligent selection? First, the purpose in view must be clear cut; whether for home or for commercial use; for canning factory or for local or more remote markets; the requirements of each market must be understood and the varieties selected should most nearly fit such requirements. Second, we must have, in the determination of varieties to grow, some knowledge of the comparative habits of both plant and fruit and should keep in mind some idea of the qualifications which go to make up an ideal variety. To be sure, no variety is perfect and the kinds grown are characterized by imperfections as well as by perfections. Doubtless no two growers would fully agree on all the qualifications which must be considered in the ideal strawberry because of different points of view and because of personal notions and tastes. Most of us, however, can fully agree on the most important factors which must be present in considering the ideal variety.

Plants of the ideal variety must of course be true to name. All are agreed on this, yet many a plant has fallen from grace on this one point alone. They should be possessed of reasonable health, vigor, and sturdiness, with no hint of weakness or lack of vitality, should multiply to such an extent as to fill all the space allotted, leaving no bare spots, yet should not encroach one upon another so as to become too crowded, and should mature their fruit at the time desired and in abundance. The flowers should preferably be perfect, although we have some excellent imperfect-flowering kinds, should not open too early in exposed localities, and should be well supplied with an abundance of pollen so that under favorable

conditions pollination carried on mostly by insects may proceed rapidly. Fruit stems should not be too short, and should be sufficiently stocky to aid somewhat in keeping the berries off the ground. The calyx should not be over large or of an unattractive color. The berries should be of good size, which is retained fairly well throughout the season, the shape pleasing in its beauty of form, and the color should tempt the eye at first sight, neither too light nor too dark but distinctly lively, bright, and clear, not green-tipped at the apex. The berries should be sufficiently firm for the purpose grown and should not reach the table in a mussy condition. Most important of all, the flesh characters should combine a commingling of pleasant aroma, delightful richness of agreeable flavor, abundant juice, and an entire lack of toughness, astringency, or insipidness. Such a combination of qualities forming just the right mixture of sweetness and acidity, should certainly tempt the appetite of the most fastidious palate.

As already has been suggested, tastes differ; some want an acid berry; others a sweet, mild berry; the point of view lacks uniformity and we all have our pet notions as to what constitutes perfection; yet it seems certain that most strawberry growers can fully agree on the importance and desirability of all these qualities just enumerated and the different varieties vary so widely in flavor and quality that even the most fastidious may find a variety suited to their particular taste.

The question of what to plant has not been fully answered. One solution to the question is by a careful study of the varieties in the immediate locality, selecting only such kinds that have by past experience proved their value and adaptation in that neighborhood. A second method is by trial of a few plants before planting largely to any little known variety. The test plat should be a regular feature of the strawberry grower and the newer and more promising kinds should be tested and their local value determined before planting commercially.

Brief mention has been made of a class of varieties that would extend the strawberry season through the fall months. Such kinds are designated as "Fall-bearing" varieties, and have created considerable discussion during recent years. It is true that a selection from the score or more of such kinds will make this fruit

available throughout August, September, and October, and there will be little trouble in supplying our tables at that time. If, however, it is proposed to set such plants extensively for commercial purposes, the writer suggests that moderation be exercised in the first plantings and that the acreage be enlarged only as the success of the previous plantings warrant.

Thus far, no varieties have been listed, and it is with hesitation that any names are given because of the fact that the most valuable kinds in one place may be worthless in some other locality. There are, however, a number of varieties which have made good in one part or another of New York State, although this fact has no bearing on their behavior in the Bay State. Many of them are old varieties with an established reputation, while others are among the more recent kinds; the following list is therefore only suggestive:

Amanda	Excelsior	Mascot
Barrymore	Gandy	Michel
Bederwood	Glen Mary	Ozark
Belt	Golden Gate	Prolific
Brandywine	Good Luck	Rough Rider
Chesapeake	Indiana	Sample
Columbia	Monroe	Stevens
Dunlap	Marshall	Williams.

Fall-bearing Kinds.

Americus Francis Progressive Superb.

In conclusion. This discussion, incomplete yet already too long, must be brought to a close. An effort has been made to set forth some of the essentials of strawberry growing, the observance or non-observance of which make or mar the final results. A successful grower cannot run his business by rule of thumb. Ways and means will vary from year to year to meet new conditions of climate, of season, and of markets. Strawberry growing is intensive farming; halfway measures cannot bring the results desired. The fruit itself as a basis of work is of highest rank, and recalls the old

saying, "Doubtless God could have made a better berry, but doubtless he never did," and with the many varieties at our disposal, and with a better knowledge of their adaptabilities, intelligent effort cannot fail to supply our tables with fruit most acceptable to both sight and taste.

CRANBERRY CULTURE.

By Marcus L. Urann, Boston.

Abstract of lecture delivered before the Society, with stereopticon illustrations, March 10, 1917.

Within a very few months the people of the United States will be considering, as never before, their food supplies. Not only in terms of great producers of grain and large special crops, but the question of food will be brought down more directly to the individual and he will be endeavoring to solve the problem of how he can himself produce some of his foods by utilizing his back yard or other small areas of land which will be open to his cultivation. One of the first questions confronting him is the selection of his crops. It is a rule that we should raise what we can cheaper than we can buy and buy from others what they can produce cheaper than ourselves. Now I presume we all want cranberries.

First, because of their food value, composed as they are of elements which our body needs and which will be of increasing value the plainer our general diet may become. For instance, tough and other poor quality of meats are rendered tender and more palatable cooked or eaten with cranberries. Then, too, they are an economical food there being no waste in cores or skins and very little labor required in preparation. We want them, too, because of their medicinal value. We are informed that cranberries contain predigested acids easily assimilated, acting directly on the red corpuscles in the blood.

Therefore desiring cranberries, the next question is whether or not we should produce or purchase them, this to be determined by the conditions under which they can successfully be grown.

The common swamp cranberry, known to botanists by the name of "*Vaccinium macrocarpon*," is found native in almost every state in the Union and in parts of Canada. All economic plants show a preference for certain soil and climatic conditions and none is more

exacting in this regard than the cranberry, easily and successfully grown on congenial soils, it is a failure under adverse conditions. The successful cultivation has been practically limited to Massachusetts, New Jersey, and Wisconsin, about two-thirds of the total crop coming from Massachusetts and these grown almost exclusively on Cape Cod, where the economic conditions seem to be peculiarly adapted to this particular fruit.

History. The first attempts at cultivation of cranberries in this country were made on Cape Cod about the year 1816. The general cultivation, however, does not date back further than the year 1850. The development since that time has been rapid until today there are in Massachusetts some 12,000 acres.

Necessary conditions. In locating a cranberry bog the first question, of course, is the soil, which should be of a peaty or alluvial nature, the decomposition of which has not reached a stage which will prevent the water percolating freely through it. The next requisite is drainage, which should be ample to allow the surface of the water to be kept at least two feet below the surface of the bog under any and all conditions. There must be an abundant water supply with the necessary reservoir privileges, providing protection from frost and insects. This water is used also in the proper development of the fruit itself. There must be an ample supply of sand easily accessible. The bog should be so located as to have a circulation of air and to be out of natural frost veins. After selecting a swamp with these necessary conditions the first step in preparation is:

Clearing. Some of the swamps on Cape Cod are covered with what is called brown brush, a swamp bush growing from two to six feet high. Many of the swamps, however, are covered with a heavy growth of pine, maple, and cedar trees, all of which must be removed, both the trees and the stumps to at least six inches below the finished grade of the bog. These trees are used for wood or lumber. After which we come to the second step.

Turfing. Which is removing all surface vegetation, cutting the turf into squares and turning upside down. It sounds very easy, but no part of bog building requires more skill and judgment, for in this turf are the seeds, roots, and plants, which, if not properly handled, will spring up for many years afterwards entailing a heavy expense, as well as cause damage to the young bog.

Ditching. After turfing, the drainage ditches are excavated, the size and number of which depend upon the area to be drained, the number of springs, and density of soil. They usually consist of a large ditch through the middle of the swamp and lateral ditches running at right angles from this to the upland; these latter are generally about two feet wide and deep. A ditch must entirely surround the bog at the point where the peaty soil of the swamp meets the sandy soil of the upland. This is to carry off the surface water and is a protection from insects crawling on to the bog from the upland. These ditches not only drain the swamp, permitting air circulation and chemical changes, which will furnish food supply to the plants, but also are necessary in case of flowage.

Dikes. The next step is to divide the entire swamp into sections according to its topography. It is advisable to have a swamp divided into sections of comparatively a few acres. This is accomplished by a system of dikes located according to the natural conditions of the bog. They are usually constructed by laying up two parallel walls of turf the desired distance apart, this turf having been cut from the surface of the swamp and then filling in between the two walls with sand from the upland. In locating these dikes it is necessary to have the area to be flowed by a given dike as nearly level as possible.

Grading. Each area separated by a dike is then graded, for which a special tool much like a hoe but heavier and sharp is used. The high places are cut down and the low places filled in, thus permitting flooding with a minimum supply of water in the shortest time, as well as an even development of the fruit.

Sanding. We must then cover the graded area with clean sand free from clay, loam, or seeds to a depth of from four to six inches according to the nature of the soil. This, as all other work on a cranberry bog, must be done by hand. The usual practice is with wheelbarrows over moveable planks. Care must be taken not to tread this sand into the peat and also to spread it to a uniform depth.

Planting. Seeds are used for originating new varieties. Meadows are established by planting cuttings from ten to fifteen inches long laid flat on the ground from ten to twenty inches apart each way. Then with a dibble placed in the middle of the cutting force the plant doubling upon itself through the sand into the peat.

The vines will then show above the sand one or two inches. The cuttings are obtained from vigorous plants by mowing a portion of a producing bog. A fully developed plant is about six inches high, the vines running along on the ground very similar to strawberries.

Time to plant. The best results have been obtained by planting during the months of April and May. The plants will then get a good start before the dry weather of the summer and the fourth year afterwards the first real crop may be expected. After this we generally expect a crop of fifty barrels per acre.

Cultivating. During the four years after the bog is built a large amount of work is involved to keep the area weeded and free from grass or other foreign growth. It is also necessary to clean out the ditches by the third year any way, as their banks have not been fully vined over and consequently the wash and caving will often fill them.

After the vines have completely covered the bog there is little trouble from weeds or other foreign growth.

Pruning. Each year, after harvesting, the bog is pruned with a razor-toothed rake removing all loose runners and leaving the vines in condition to produce uprights upon which the fruit grows.

Resanding. About every other year it is desirable to spread upon the surface of the bog a thin layer of sand. This also must be done by hand, unless as some growers and under certain conditions, may make the application on the ice in the winter.

Management. The cranberry industry is one of the most highly developed fruit specialties in the country. To be successful it requires years of experience and study and the demands in this respect are increasing every year.

Harvesting. Formerly cranberries were harvested by hand. Since the industry has expanded however, certain devices have been invented, only a few of which have stood the test of time and experience.

The month of September is really the harvesting month. It may begin in August and some times extends into October. The fruit as harvested is placed in ventilated boxes usually containing one bushel, in which they are carried to the packing house and there allowed to remain until properly cooled, after which they are put through certain machines for removing leaves, vines, soft and

injured fruit. From these machines they pass to belts or tables, to be picked over by hand. From here they pass into barrels containing one hundred pounds.

During this same time the berries are graded according to size, color, quality, etc.

Marketing. While there are still some independent growers who sell their own berries depending on locating their own markets, or through commission men, the larger part of the berries are sold through a coöperative association of the growers. The different grades of berries are given brands, which brand name indicates certain specifications in size, color, quality, and variety. This coöperative organization does the work at actual cost to the grower, maintaining offices and in all ways carries on the business as usually followed by coöperative associations. It has proven very successful and a great benefit to the business.

Formerly there was little care on the part of the consumers as to the kind of berries received, all cranberries being alike to them. In recent years, however, the markets are growing more and more particular demanding car loads of an even grade, quality, and pack of fruit.

Insect enemies. There are three classes of insects, those that attack the fruit, the vine, and the root, to combat which the main reliance is upon water. A bog that has no water must depend upon spraying with poisons.

In conclusion let me express the hope that the time is not far distant when Massachusetts will appreciate more than she does now, the importance of this highly specialized industry within her borders. The next ten years should reach a crop of five hundred thousand barrels a year and an average selling price of six dollars per barrel should mean three million dollars annually and nearly all of it is money coming into the State, for this is the one big crop in Massachusetts which is exported. A cheap and healthful food, which should be used more liberally in every family because of its food and medicinal value, its economy and the many uses to which it can be put, for there are few foods which lend themselves to so universal a use in cooking as cranberries.

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